Webasto
Feel the drive

Air Heater

Air Top 2000 ST D (Diesel)
Air Top 2000 ST B (Gasoline)

Service and Repair Manual

- Improper installation or repair of Webasto heating and cooling systems can cause fire or the leakage of deadly carbon monoxide leading to serious injury or death.
- Installation and repair of Webasto heating and cooling systems requires special Webasto training, technical information, special tools and special equipment.
- NEVER attempt to install or repair a Webasto heating or cooling system unless you have successfully completed the factory training course and have the technical skills, technical information, tools and equipment required to properly complete the necessary procedures.
- ALWAYS carefully follow Webasto installation and repair instructions and heed all WARNINGS.
- Webasto rejects any liability for problems and damage caused by the system being installed by untrained personnel.

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1. INTRODUCTION

1.1 Contents and Purpose

This repair shop manual is intended to assist trained personnel with repairing both the gasoline and the diesel versions of the Air Top 2000 ST air heaters.

1.1.1 Use of the Air Heaters

The Webasto Air Top 2000 ST air heaters are designed

- to heat cabins, boats, trucks, minibuses, vans, ambulances and motor homes.
- to defrost vehicle windows.

They are not designed for heating cargo areas used to carry hazardous substances.

The heaters operate independently of the engine and are connected to the fuel tank and the electrical system of the vehicle.

They are not designed for installation in vehicles with water or air-cooled engines.

1.2 Meaning of Signal Words

Throughout this manual, the signal words DANGER, WARNING, CAUTION, and NOTE have the following meanings:

DANGER: This heading and text style is used to highlight that non-compliance with instructions or procedures will cause injuries or lethal accidents to personnel.

WARNING: This heading and text style is used to highlight that non-compliance with instructions or procedures may cause injuries or lethal accidents to personnel.

CAUTION: This heading and text style is used to highlight that non-compliance with instructions or procedures may cause damage to equipment.

NOTE: *This heading and text style is used to highlight and draw attention to information we feel you would like to have. It could have to do with procedures and tips that will help you work more efficiently.*

1.3 Additional Documentation

This workshop manual contains all the information and instructions required for repairing Air Top 2000 ST air heaters. The use of additional documentation is not normally required. If necessary, the operating / installation instructions and the installation suggestion for the specific vehicle may also be used.

1.4 Safety Information and Regulations

In principle, the general accident prevention regulations and current works safety instructions are applicable.

The "General safety regulations" that go beyond the scope of the above regulations are stated below (see 1.4.2).

Any special safety regulations relevant to this instruction manual will be highlighted in the relevant sections or text passages of the procedures.

1.4.1 Statutory Regulations and Safety Instructions

NOTE: *The provisions of these Directives are binding within the United States of America by FMCSA Directive 393.77 and should similarly be observed in countries without specific regulations.*

Extract from the Federal Motor Carrier Safety Administration

Part 393: Parts and Accessories Necessary for Safe Operation

§393.77 Heaters

(b)(15) Certification required.

Every combustion type heater, shall be marked plainly to indicate the type of service for which such heater is designed and with a certification by the manufacturer that the heater meets the applicable requirements for such use. For example, "Meets FMCSA Bus Heater Requirements."

1.4.2 General Safety Information

The mouth of the exhaust pipe should be installed upwards, to the side or, if the exhaust pipe passes under the floor of the vehicle, to the side or rear limit of the driver's cab or the vehicle.

The function of important parts of the vehicle must not be adversely affected. It must not be possible for condensate or water to collect in the exhaust pipe. Drain holes may be used.

The electric cables and controls for the air-conditioning system must be arranged in the vehicle so that their proper functioning cannot be adversely affected in normal operating conditions.

The following points for the installation of fuel lines and the installation of additional fuel tanks must be observed.

- Fuel pipes must be designed in such a way that torsion in the vehicle, movements by the engine and the like do not have a negative effect on their durability. They must be protected from mechanical damage.
- Parts that carry fuel must be protected from heat that will adversely affect their function and positioned so that dripping or evaporating fuel cannot collect or ignite on hot parts or on electrical equipment.
- The fuel lines (Mecanyl hose) must not be immediately next to the exhaust pipe and must be thermally insulated if necessary, otherwise they will pose a fire risk.
- All pipes that come into contact with fuel must have sealed connections, they must not be damaged in any way and the must be checked at regular intervals (at least the same intervals as for inspection of the vehicle as a whole).

NOTE: *If any damage or leaks are found on the fuel line, the heater must not be used until the damage has been rectified by an authorized Webasto workshop.*
Put the heater out of action by removing the fuse.

Installation regulations for Webasto fuel tanks for supplying fuel to heaters in vehicles:

- The tank must not be installed in the passenger or driver's cabin of buses.
- The fuel filler neck must not be inside the passenger or driver's cabin in any vehicle.
- Fuel tanks for normal or super grades of petrol must not be immediately behind the front trim of the vehicle. They must be separated from the engine in such a way that in the event of an accident the fuel will not be expected to ignite. This does not apply to tractor units with an open driver's seat.

The air heater's heat exchanger can be used for a maximum of 10 years and must then be replaced by the manufacturer or one of its authorized workshops using a genuine spare part. A label must then be affixed to the heater showing the date of sale and the wording "Genuine spare part".

When you change the heat exchanger it is essential that you also replace the overheating protection element (overheating sensor) to prevent possible function faults caused by using the old overheating sensor.

The Air Top 2000ST air heaters are prepared for interior installation and sealing directly on the cabin floor or a cabin wall. Non-release connections must be used in the interior for combustion air and exhaust pipes with the accessories available from Webasto.

The seal between the heater mounting and the vehicle floor must always be installed; otherwise harmful emissions may get into the interior of the vehicle.

The hot and combustion air intake openings must be positioned in such a way that no water can ingress into them if the vehicle drives through a water hazard for which it has been approved.

For passenger carrying vehicles such as shuttle busses, transit busses, and coaches, where the heater is to be installed in the passenger cabin, a protective cover or installation box should be installed over the heater to prevent contact with hot surfaces by passengers and heat sensitive objects.

The protective cover or installation box must have sufficient external ventilation to ensure that a maximum temperature of 40°C (104°F) is not exceeded in the box. Malfunctions may occur if the temperature exceeds this level.

The heater must be switched off at filling stations and fuel tank farms because of the risk of explosion.

Wherever inflammable vapors or dust may form (for example near fuel, coal, wood dust or cereal stores or the like), the heater must be switched off because of the risk of explosion.

The heater must not be operated in enclosed areas, such as garages or workshops without an exhaust emissions extraction system, not even using the timer, because of the risk of asphyxiation and poisoning.

In the event of lengthy heavy smoke development, unusual combustion noise or a smell of fuel, the heater must be put out of action by removing the fuse and must not be started again until it has been examined by Webasto-trained personnel. Liability claims can only be lodged if the claimant can prove that he has complied with the servicing and safety instructions.

Overheating

Keep hot air inlet and hot air outlet free of dirt and other items. Dirty, blocked air lines can cause the heater to shut down due to overheating.

After an overheating lock-out, check that the air system is clear, remove any materials that may block the air flow and have any damage to the air lines repaired by an

authorized Webasto workshop. After this the heater lock-out can be cancelled by switching it off and then on again. If this action does not produce the required success (if the heater overheats again) take it to a Webasto-authorized workshop. Never remove the grating over the air inlet of the heater.

The air outlet jets or air vents with adjustable flaps must always be opened to some extent so that the air flow through the heater is not completely blocked. At least one air vent must be prevented from being closed.

If the heater is installed in a storage area, you must ensure that no inflammable substances are kept in this area and that other material does not restrict the air supply to the heater.

Air lines must be securely fixed to the heater (using pipe clips, for example) and all other connection points (for example vents).

IMPORTANT! The errors described below are to be avoided at all costs:

- Do not stand on the heater or place or throw any heavy objects on the heater.
- Do not place any items of clothing, textiles or similar materials over the heater or in front of the hot air inlet side and hot air outlet.
- The flow of hot air from the heater must not be restricted or blocked by highly inflammable substances or materials such as rags, cleaning wool, etc.
- Inflammable or explosive substances and gases must not be placed near or in contact with the heater, the hot air line, the flow of hot air or the exhaust pipe.
- The heater must not be cleaned with a high pressure cleaner.
- Do not switch the heater off at the main battery switch or battery isolation switch since otherwise it is possible that it may suffer long term damage if it is switched off frequently using the battery isolation switch and this can cause damage and negative influences on the function of the heater.

NOTE: *Failure to follow the installation instructions and the notes contained therein will lead to all liability being refused by Webasto The same applies if repairs are carried out incorrectly or with the use of parts other than genuine spare parts. This invalidates the type approval for the heater and its homologation / EC type permit.*

You must read the operating manual before starting the heater for the first time.

1.5 Suggestions for Improvements and Changes

Complaints, improvement suggestions or corrections relating to this workshop manual should be addressed to

Webasto Product North America, Inc.
Technical Documentation Group
15083 North Road
Fenton MI 48430

Phone: 810.593.6000

PC-Fax: 810.593.6135

This page for your notes.

2. GENERAL DESCRIPTION

The Air Top 2000 ST air heater is based on the evaporator principle and essentially consists of the following:

- the drive unit with a combustion and hot air blower
- the heat exchanger
- the burner insert with combustion pipe
- the control unit

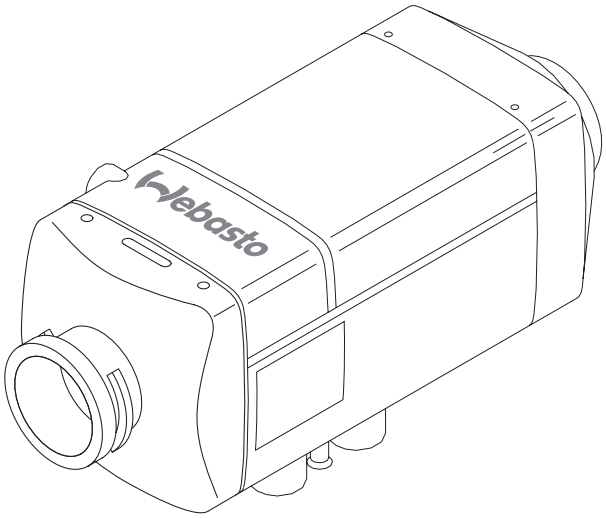

Figure 1: Air Top 2000 ST Air Heater

To control and monitor it, the heater has

- a control unit with temperature sensor
- a flame sensor (gasoline heaters only)
- a ceramic glow pin
- an overheating sensor

inside it.

All Air Top 2000 ST heaters can also be controlled using an external temperature sensor.

The fuel supply is provided from an external source using a metering pump.

If a fault occurs, an error code will be output in the display of the combination or standard timer. If the heater has a control element, the ON control light will flash.

In addition, the heater can be checked using a personal computer (see PC heater diagnostic operating manual).

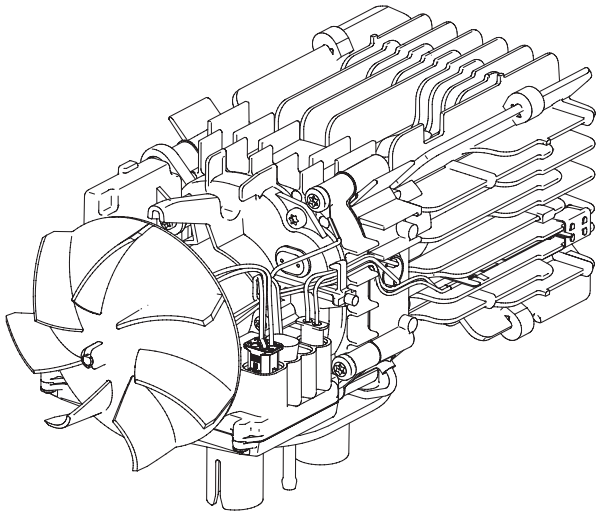

Figure 2: Air Top 2000 ST Air Heater without Casing

2.1 DRIVE UNIT

The drive unit consists of the drive motor, the combustion air blower, the heat air blower and the intake casing.

The combustion air blower supplies the air required for the combustion process from the combustion air inlet to the burner insert.

The removable hot air blower transports the hot air from the hot air inlet via the heat exchanger to the hot air outlet.

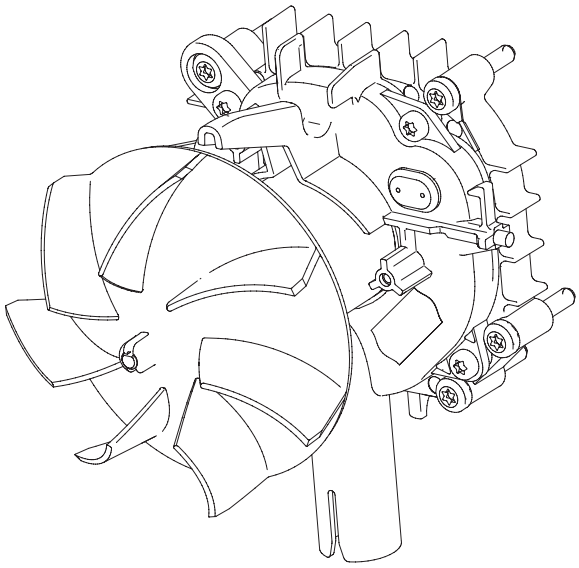

Figure 3: Drive Unit

2.2 Heat Exchanger

The heat generated by the combustion process is transferred to the air transported by the combustion and hot air blowers in the heat exchanger.

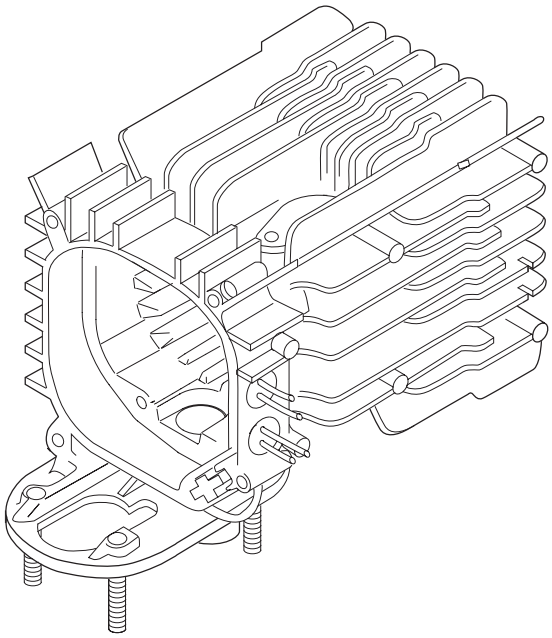

Figure 4: Heat Exchanger

2.3 Burner Insert with Combustion Pipe

The fuel is distributed over the burner cross-section in the combustion pipe in the burner insert. The mixture of fuel and air burns in the combustion pipe, thus causing the heat exchanger to become hot.

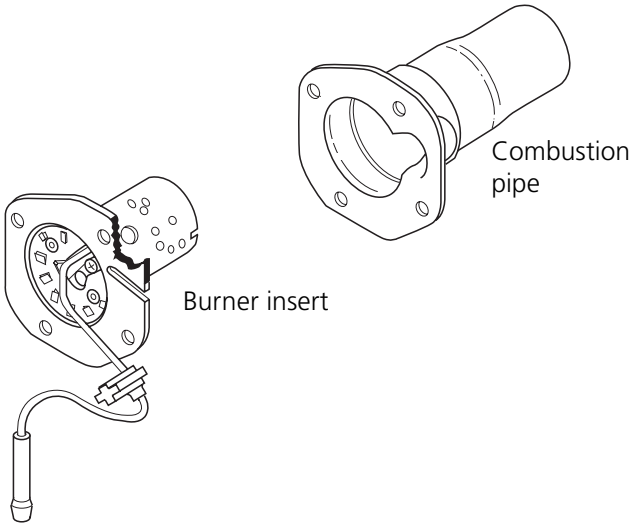

Figure 5: Burner Insert with Combustion Pipe

2.4 Control Unit

The control unit is the central component for ensuring the function is maintained and for monitoring the heater's operation. A temperature sensor in the control unit is designed to control the room temperature. An external temperature may also be connected to all the heaters.

If a fault occurs, an error code will be output in the display of the combination timer. If the heater has a control element, the ON control light will flash.

In addition, the heater can be checked using a personal computer (see PC heater diagnostic operating manual).

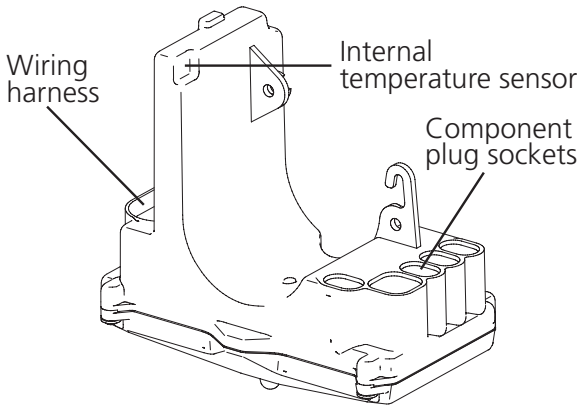

Figure 6: Control Unit

2.5 Flame Sensor (Gasoline Heaters Only)

The flame sensor is a low-ohm PTC resistor, which changes its resistance depending on the heat emitted by the flame.

This change in resistance is analyzed by the control unit so that the flame status is monitored whenever the heater is operating.

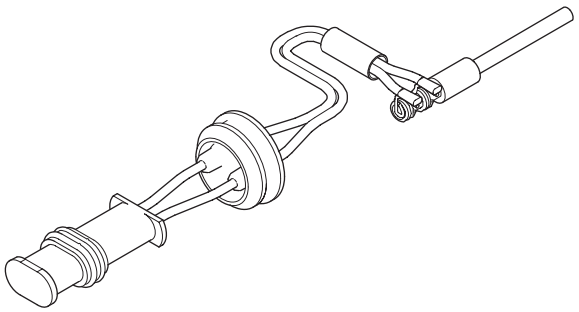

Figure 7: Flame Sensor

2.6 Ceramic Glow Pin

The mixture of fuel and air is ignited by the glow plug when the heater is started. The glow pin takes the form of an electrical resistor and is positioned in the burner insert on the side away from the flame.

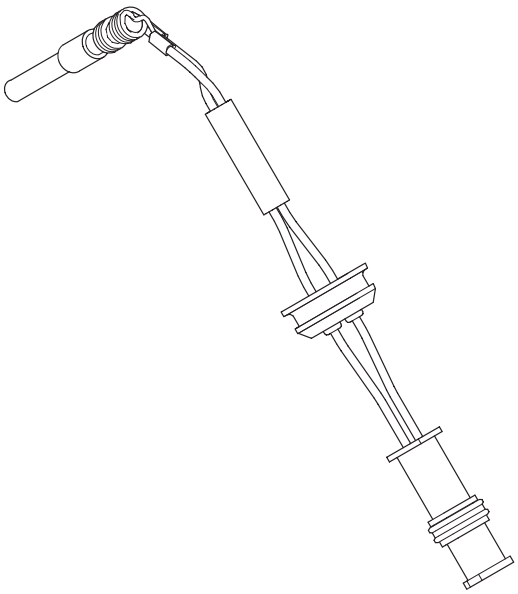

Figure 8: Ceramic Glow Pin

2.7 Overheating Sensor

The overheating sensor measures the temperatures in the rib area of the heat exchanger whenever the heater is operating. The control unit evaluates the signal and protects the heater from hot air outlet temperatures above 150 °C and surface temperatures above 80 °C by shutting down the combustion process and blowing cold air over the heater.

The heater then suffers a fault lock-out and can be restarted by being switched off and then on again (see 3.2).

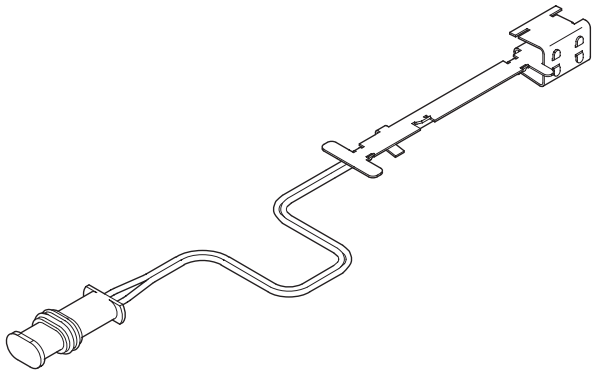

Figure 9: Overheating Sensor

2.8 Fuel Metering Pump

The metering pump is a combined transport, metering and shut-off system for supplying fuel from the vehicle's tank to the heater.

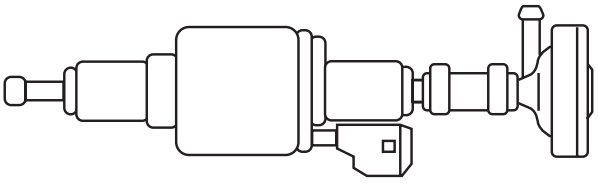

Figure 10: Fuel Metering Pump DP 30.2/3 (with Damper)

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3. FUNCTIONAL DESCRIPTION

3.1 CONTROL ELEMENT (RHEOSTAT)

The control element is designed to switch the heater on and off, adjust the required room temperature (intake temperature between 5 °C and 35 °C) and to reset the heater after a fault.

The green LED serves as the On indicator (LED permanently lit up) and as a fault signal (LED flashes).

3.2 SWITCH ON

Set the control element to the required temperature.

If the hot air temperature is lower than the nominal temperature, the heater will start.

NOTE: *If the temperature of the hot air intake is above the set nominal temperature, only the motor for the hot and combustion air blower will start (control pause). Special feature: The control pause speed is 0 rpm if boat heaters are used.*

The function of the flame sensor is checked. If the flame sensor now reports "light", the system will attempt to cool the flame sensor for 60 seconds. If the flame sensor still reports "light" the control unit will suffer a fault lock-out. If another monitored component has suffered a fault, the fault lock-out will take effect without any slow down time.

Start

When the heater is switched on, the ON signal light will be lit and the glow plug will be switched on (cycled). The motor for the hot and combustion air blower will be set to approx. 50% of its maximum speed.

After approx. 40 seconds the fuel metering pump will start, and the flame formation will begin. To improve the starting quality the metering pump and combustion air blower are started with different frequencies and speeds. After a further 95 seconds (gasoline) or 110 seconds (diesel) the glow pin will be switched off and the existence of the flame established.

Automatic Restart

If no flame is detected, the starting procedure will be repeated. The glow plug will be switched on again (cycled). The motor for the hot and combustion air blower will be set to approx. 25% of its maximum speed.

After approx. 30 seconds (petrol) or 50 seconds (diesel) the fuel metering pump will start, and the flame formation will begin. After a further 65 seconds (petrol) or 90 seconds (diesel) the glow plug will be switched off and the existence of the flame established.

If the heater has again failed to ignite properly, the heater will be shut down using a fault slow down procedure at maximum speed after 180 seconds and will suffer a fault lock-out.

NOTE: *After a restart the heater will suffer a fault lock-out. To reset the fault switch the heater off briefly (min. 2 seconds) and switch back on.*

3.3 HEATING MODE

While the heater is operating, the combustion gases pass through the heat exchanger. During this process the combustion heat is given off to the walls of the heat exchanger, absorbed by the hot air transported by the hot air blower and fed into the interior of the vehicle.

The temperature of the hot air intake is measured by a temperature sensor on the intake side of the heater or an external temperature sensor. If the measured temperature is lower than the value set on the control element, the output of the heater is increased to maximum heat output.

To increase the burner service life when it is used continuously the transport capacity of the metering pump is reduced for 10 seconds every 10 minutes. In addition, heating mode is interrupted every 8 hours in the same way as for a control pause.

3.4 CONTROL MODE

In control mode the blower speed and the metering pump delivery rate are dependent on the heat output. The glow pin is switched off.

3.5 CONTROL PAUSE

After the temperature set on the control element has been reached, the heat output is reduced. The speed of the heating and combustion air blower and the delivery rate of the metering pump are reduced.

If, at minimum heat output, the intake temperature set on the control element is exceeded, the metering pump is shut down and the combustion process ended. To burn off the flame properly the blower speed falls after 20 seconds to low-fire rate speed and then returns to the initial speed after 15 seconds, after which it falls to the control pause speed in 3 minutes, where it remains for the entire control pause.

The control pause speed on boat heaters is 0.

If the temperature set on the control element is not observed at the temperature sensor, the heater will restart.

NOTE: *Changes to the setting on the control element are implemented by the control unit and heater after a delay.*

3.6 SWITCH OFF

When the heater is switched off, the ON control LED on the control element goes out. If no fuel has been transported or if the heater is in the control pause, the heater is switched off immediately without a slow down time.

If the fuel transport has been started, it is ended immediately when the heater is switched off. The heater is switched off using the same method as the transition from control mode to control pause. The device is then switched off automatically.

NOTE: *The heater may be switched on again during the slow down time. In this case the slow down time is completed and the heater is then restarted.*

3.7 FAULT LOCK-OUT

The control unit has identified errors on individual heater components and faults during the starting procedure and in operation. The heater is switched off and goes into fault lock-out if the following conditions occur:

- No repeated or incorrect start
- Temperature sensor defective
- Overheating sensor interrupt or short circuit
- Overheating sensor installed incorrectly
- Glow pin interrupt or short circuit
- Blower motor overload or blocked or short circuit or break
- Flame sensor interrupt or short circuit
- Error in the metering pump or overheating guard circuit (start phase only)
- Under voltage below 10.5 V / 21 V for longer than 20 seconds
- Over voltage above 16 V / 32 V for longer than 6 seconds
- Control module defective

The fuel supply is stopped if the heater overheats. The heater continues to run in the same way as if it is switched off manually. After it stops the control unit will be set to fault lock-out. After the slow-down phase the control module is set to fault lock-out if the overheating counter is greater than the value programmed in the data record (currently 20).

The overheating is indicated by the indicator flashing 10 times.

Rectify the cause of the fault.

To reset the fault, switch the heater off briefly (at least 2 seconds) and then on again.

3.7.1 Error Monitor

The overheat, incorrect start and flame failure errors are counted and cause the heater to suffer a fault lock-out after an error has occurred the maximum number of times.

The incorrect start counter FSZ is incremented by 1 each time the heater fails to start and decremented by 1 each time it starts correctly, but does not fall below 0. If the incorrect start counter reaches its maximum value of 7, the heater will go into the heater lock-out status HGV.

The error counter SZ is incremented by 1 with each error for which there is no separate counter. The error counter is reset to 0 at the start of control mode. If the error counter reaches its maximum value of 10, the heater will go into the heater lock-out status HGV.

The overheating counter ÜHZ is incremented by 1 each time the heater overheats. If the overheating counter reaches its maximum value of 20, the heater will go into the heater lock-out status HGV.

The flame failure counter FAZ is increased by 1 each time the flame fails during heating mode. The counter is decremented by 1 each time the heater is in control mode.

If the FAZ reaches a value of 6, the heater will go into fault lock-out mode and the permanent flame failure counter FAZP will be incremented by 1. In control mode the permanent flame failure counter FAZP will be decremented by 1. When the heater is burning properly again, the FAZP will return to 0 after a few control cycles. If the permanent flame failure counter exceeds its maximum value of 6, however, the heater will go to permanent heater lock-out status (error code F12).

3.7.2 Reset a Fault Lock-out

The various fault lock-outs can be reset as follows.

Fault lock-out:	Switch heater off using the control element and then on again after more than 2 sec.
Heater fault lock-out:	Remove the fuse and reinsert it

This page for your notes.

4. TECHNICAL DATA

Except where limit values are specified, the technical data listed in the table refer to the usual heater tolerances of ±10% at an ambient temperature of +20 °C (+68 °F) and at the rated voltage and in rated conditions.

Electrical components:

The control unit, combustion air blower (drive), metering pump, timer, glow plug and control element are designed for 12 V or 24 V.

The components temperature sensor and flame monitor (only petrol heater) are not designed for a specific voltage.

Fuel for Air Top 2000 ST B (gasoline):

The fuel specified by the manufacturer must be used.

Fuel for Air Top 2000 ST D (diesel/PME):

The diesel fuel specified by the vehicle manufacturer must be used.

We know of no negative influences due to additives.

If fuel is extracted from the vehicle's tank, follow the additive instructions issued by the vehicle manufacturer.

If you change to low-temperature fuel, the heater must be operated for approx. 15 minutes so that the fuel system is filled with the new fuel.

The Air Top 2000 ST D heater is also licensed for use with PME (bio-diesel), which complies with ASTM D6751 and DIN EN 14214.

HEATER	Operation	AT 2000 ST B	AT 2000 ST D	
Type Test Permit	EMC Heater	e1*72/245*95/54*1085*-- e1*2001/56*0022*--		
Model		Air heater with evaporator burner		
Heat Output kW Btu/h	Control Range	1.0 - 2.0 kW 3415 - 6830	0.9 - 2.0 kW 3074 - 6830	
Fuel		Gasoline	Diesel #1, #2, Arctic, PME and Kerosene	
Fuel Consumption l/h gal/h – US	Control Range	0.14...0.27 0.037...0.071	0.12...0.24 0.032...0.063	
Rated Voltage		12 V	12 V	24 V
Operating Voltage Range V		10.5 - 16 V	10.5 - 16 V	21 - 32 V
Rated Power Consumption	Control Range	14 - 29 Watts		
Maximum Ambient Temperature: Heater -operation -warehouse Dosing Pump -operation -warehouse Control Element -operation -warehouse		 –40 °C... +40 °C (–40 °F... +104 °F) –40 °C... +85 °C (–40 °F... +185 °F) –40 °C... +20 °C (–40 °F... +68 °F) –40 °C... +85 °C (–40 °F... +185 °F) –40 °C... +75 °C (–40 °F... +167 °F) –40 °C... +85 °C (–40 °F... +185 °F)		
Max. Combustion Air Inlet Temperature		–40 °C... +20 °C (–40 °F... +68 °F)		
Adjustment Range For Interior Temperature	Control Range	+5 °C... +35 °C (+41 °F... +95 °F)		
Delivery Rate For Hot Air At Fan Speed	against 0.5 bar against 7.25 PSI	Max. 93 m^3/h at 4750 rpm Max. 55 cfm at 4750 rpm		
Co_2 In Exhaust Gas (permanent function range)	1 kW 2 kW	5.0... 8.0 9.0... 12.5	5.0... 8.0 9.0... 12.5	
Heater Dimensions Length X Width X Height		311 mm L X 120 mm W X 121 mm H 12.25 in L X 4.72 in W X 4.76 in H		
Weight Of Heater		2.6 kg (5.73 lb)		

Table 1. Technical data

This page for your notes.

5. TROUBLESHOOTING

5.1 GENERAL

This section describes how to identify and remedy faults on the Air Top 2000 ST air heater.

If a fault occurs, an error code will be output in the display of the combination timer. If the heater has a control element, the ON control light will flash. In addition, the heater can be checked using a personal computer (see PC heater diagnostic operating manual).

CAUTION: Troubleshooting work demands precise knowledge of the structure and theory of operation of the various components and must be carried out by trained personnel only.

If in doubt, refer to sections 2 and 3 for a description of how the functions interact.

CAUTION: The troubleshooting guide is restricted to the localization of defective components. The following potential sources of malfunctions have not been included and should always be checked so that they can then be excluded as the cause of the particular fault:

- **Corrosion on plugs**
- **Loose plug contacts**
- **Poor crimp contacts on plugs**
- **Corroded cables and fuses**
- **Corroded battery terminals**

If you wish to check individual components, the electrical plug connectors on the control unit must be disconnected.

Conduct a function test in the vehicle after rectifying each fault.

5.2 GENERAL ERROR SYMPTOMS

The following table lists the possible error symptoms.

Error Symptom	Possible Cause	Remedy
Heater cuts out automatically	No combustion after start and restart ON indicator flashes	Switch heater off and then on again
	Flame extinguishes during operation ON indicator flashes	Switch heater off and then on again
	Heater overheats ON indicator flashes	Check that the hot air system is clear, allow the heater to cool, switch heat off briefly and then on again
	Battery voltage too low ON indicator flashes	Charge battery Switch heater off and then on again
Heater produces black smoke	Combustion air and/or exhaust system blocked	Check that the combustion air and exhaust systems are clear

Table 2. General Error Symptoms

5.3 Error Symptoms during Function

The following table lists the possible error symptoms in the order in which they may occur during operation.

In the event of a fault, the error is to be located using this table and rectified. It is important that the error symptom is correctly identified.

If the error symptom is not included in this table or the fault is not found under the specific error symptom heading, in an emergency you can contact our technicians on our service hotline (see last page).

NOTE: *Every fault is indicated by the flashing LED on the control element after the slow down time has finished. If the other components are OK, a defective control unit may be the cause of all the faults.*

There are statuses that are the same as errors.

Error Symptom	Occurrence	Remedy
No start and no illumination of the LED on the control element	Immediate	Incorrect cabling, defective fuse
No start but LED is lit	Immediate	The heater goes straight to control pause when it is switched on, whereby the control pause speed is 0 rpm for a boat heater.

Table 3. Error Symptoms during Function

5.4 Error Code Output

If the heater is fitted with a combination timer, an error code output will appear on the display of the timer after a fault occurs.

NOTE: *The error code is output if the heater is fitted with a control element after an error has occurred by the switch-on indicator/error code indicator flashing. After 5 seconds of fast flashing, the error code will be output by a sequence of long flash pulses, the number of flashes is shown in the table below (for example F04 – 4 long flash pulses).*

Error Code	Error (group)	Additional Information during PC Diagnostics	Remedy
F 00	Control unit error	**01** Control unit error **81** EOL checksum error **11** Incorrectly coded control unit or incorrect heater (fuel type) installed (the heater will not work if this error occurs) **91** Neutrally coded or disabled control unit (the heater will not work if this error occurs) **92** Maintain command failed (the heater will not work if this error occurs) **18** Customer bus defective	Replace control unit
F 01	No start	**02** Even after the restart, no flame has formed **82** No start in test	Check fuel supply (tank empty, lines blocked) Clean burner insert, Gasoline: Replace flame sensor Diesel: Replace overheating sensor / control unit
F 02	Flame failure	**03** The flame has gone out during operation and has not reformed after a restart attempt **83** The flame has gone out during a heating cycle more than FAZ times (EEPROM)	Check fuel supply (tank empty, lines blocked) Clean burner insert, Gasoline: Replace flame sensor Diesel: Replace overheating sensor / control unit
F 03	Under-voltage or over-voltage	**84** The voltage was less than 10.5 V or 21 V for longer than 20 seconds **04** The voltage was more than 16 V or 32 V for longer than 6 seconds	Charge battery

Table 4. Troubleshooting (page 1 of 3)

Error Code	Error (group)	Additional Information during PC Diagnostics	Remedy
F 04	Premature flame recognition	**05** A flame was detected before combustion had started	Diesel: Replace overheating sensor / control unit Gasoline: Replace flame sensor
F 05	Flame sensor interrupt or short circuit (gasoline heaters only)	**1A** Flame sensor circuit The switched cable of the element has a short circuit to earth	Replace flame sensor
		9A Flame sensor circuit Break or short circuit to +Ub	Replace flame sensor
F 06	External temperature sensor break or short circuit	**14** Temperature sensor circuit Short circuit to earth	Check cables / replace temperature sensor
		94 Temperature sensor circuit break or short circuit to +Ub	Check cables and terminating resistor / replace temperature sensor
F 07	Metering pump interrupt or short circuit	**88** Break or short circuit to +Ub	Check cables / replace metering pump
		08 Short circuit to earth	Check cables / replace metering pump
F 08	Drive unit (combustion and hot air blower) break or short circuit	**89** Break or short circuit to +Ub	Replace drive unit (combustion and hot air blower)
		09 The switched drive unit cable (combustion and hot air blower) has a short circuit to earth or the drive unit is overloaded	Eliminate the cause of the blockage / difficulty in movement Replace drive unit (combustion and hot air blower)
		15 Burner motor block guard has tripped	
		95 Burner motor blocking detection has tripped	
F 09	Glow pin interrupt	**8A** Glow pin: Break or short circuit to +Ub	Replace glow pin
	or short-circuit	**19** Glow circuit The switched cable of the element has a short circuit to earth	Replace glow pin

Table 5. Troubleshooting (page 2 of 3)

Error Code	Error (group)	Additional Information during PC Diagnostics	Remedy
F 10	Overheating	**06** The overheating fault lock-out has tripped (heater overheated) **17** Incorrect application or illegal insulation (ÜHS gradient too high)	Find and remove the cause of the overheating **NOTE** *If no other cause can be found for the overheating, the pressure losses caused by the hot air distribution (too many resistance points) are too high or a hot air filter is soiled*
F 11	Overheating sensor interrupt or short circuit	**AB** Overheating sensor circuit break or short circuit to +Ub **1B** Overheating sensor circuit. The switched cable of the element has a short circuit to earth	Replace overheating sensor Replace overheating sensor
F 12	Heater fault lock-out	**07** The heater fault lock-out has been activated	Remove the fuse and then refit it **NOTE** *The following error has occurred several times:* *Fault counter more than 3 times* *Incorrect start counter more than 9 times* *Overheating counter more than 3 times*
F 14	Overheating sensor incorrect position	**97** Incorrect position of overheating sensor (ÜHS gradient too low)	Position the overheating sensor correctly
F 15	Nominal sensor break	**9B** Nominal value potentiometer circuit break or short circuit to +Ub	Check cables / replace control element

Table 6. Troubleshooting (page 3 of 3)

This page for your notes.

6. FUNCTIONAL TESTS

6.1 General

This section describes the tests conducted on the heater when it is installed and not installed to verify that it is in working order.

WARNING: The heater must not be operated in enclosed areas such as garages and workshops without an emissions extraction system.

6.2 Settings

6.2.1 Setting the CO_2 Content

The CO_2 content in the emissions is set using the adjustment knob on the control element. At a constant blower speed the volume of fuel is controlled by changing the metering pump cycle.

CAUTION: The CO_2 measuring instruments must be calibrated.

The heater must be switched off.

1. Connect the CO_2 line to minus.
2. Turn the adjustment knob on the control element to the centre setting. The heater will start and go automatically to low-fire rate mode.

NOTE: *If the heater can be adjusted, the operating indicator will flash as if the control unit has suffered an error.*

Diesel Unit:

3. Set the CO_2 value by turning the adjustment knob. Turning it anti-clockwise will reduce the CO_2 value, whilst turning it clockwise will increase it. The measured CO_2 content at low-fire rate (1.5 kW) must be between 5.0% and 8.0%. In high-fire mode, the CO_2 content should be 10.3 +/- 0.5% v/v after the setting has been made.

Gasoline Unit

4. The CO_2 content may only be measured when the unit is at operating temperature. The unit must be run for at least 8 minutes for this purpose. After this the CO_2 content is to be set to 6.1 - 6.2% v/v in low-fire mode (1 kW). In high-fire mode, the CO_2 content should be 9.9 +/- 0.4% v/v after the setting has been made.
5. If the CO_2 value is within this range, disconnect the CO_2 line from minus. This saves the setting.

NOTE: *The heater will now run in normal mode again and can be switched off as normal using the control element. The heater is set at the factory to match the fitted combustion air blower.*

6.3 Testing Individual Components

CAUTION: For function tests always break the connection between the control unit and the component you wish to test.

6.3.1 Ceramic Glow Pin Resistance Test

NOTE: *The resistance test must be carried out with an ohmmeter suitable for small resistance values. A resistance test with a simple digital multimeter is too inaccurate to find the precise values. A new glow plug can be measured to act as a reference.*

The glow pin should have the following values in the test:

Glow plug:	12 V (red)	24 V (green)
Resistance at 25 °C (77 °F):	0.263 ... 0.323 Ohm	1.125 ...1.375 Ohm
Test current:	< 5 mA	< 5 mA

6.3.2 Resistance Test on Flame Sensor (gasoline heaters only)

If you conduct this test with a digital multimeter, the flame sensor must have the following values:

Cold Testing:

Resistance at 25 °C (77 °F):	2.6 ... 3.4 Ohm
Test current:	< 5mA

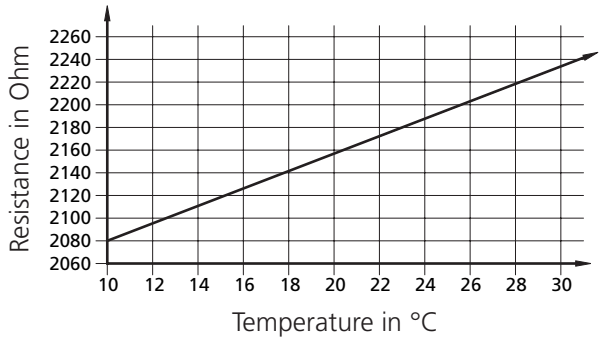
Hot Testing:

Resistance at 800 – 1000 °C:	12 ... 15 Ohm
Resistance at 1472 – 1832 °F:	12 ... 15 Ohm
Test current:	< 5 mA

(ceramic rod at red heat over length of approx. 20 mm)

6.3.3 Overheating Sensor Resistance Test

If you conduct this test with a digital multimeter, the overheating sensor must have the values shown in the following diagram:



Characteristic resistance values of a
PT 2000 overheating system
in a temperature range of 10 °C to 30 °C

Conversion chart (°C to °F):

10 °C = 50 °F
12 °C = 53.6 °F
14 °C = 57.2 °F
16 °C = 60.8 °F
18 °C = 64.4 °F
20 °C = 68 °F
22 °C = 71.6 °F
24 °C = 75.2 °F
26 °C = 78.8 °F
28 °C = 82.4 °F
30 °C = 86 °F

7. CIRCUIT DIAGRAMS

7.1 GENERAL

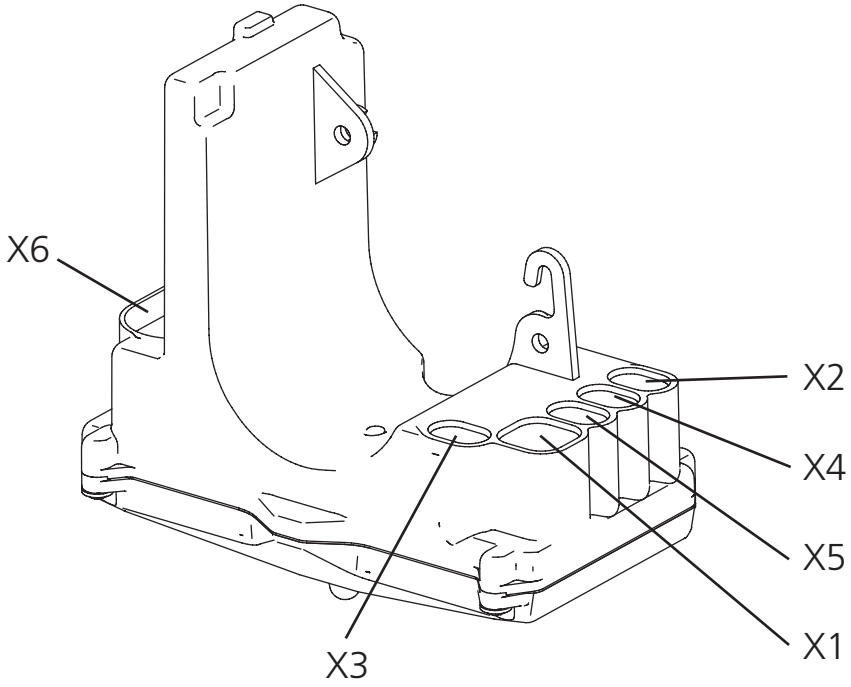
The Air Top 2000 ST heater can be controlled with the control element (nominal value adjuster/switch) or a combination timer.

The circuit diagrams (Fig. 12 and Fig. 13) show the possible circuits for 12 and 24 V with:

- Control element
- Combination timer

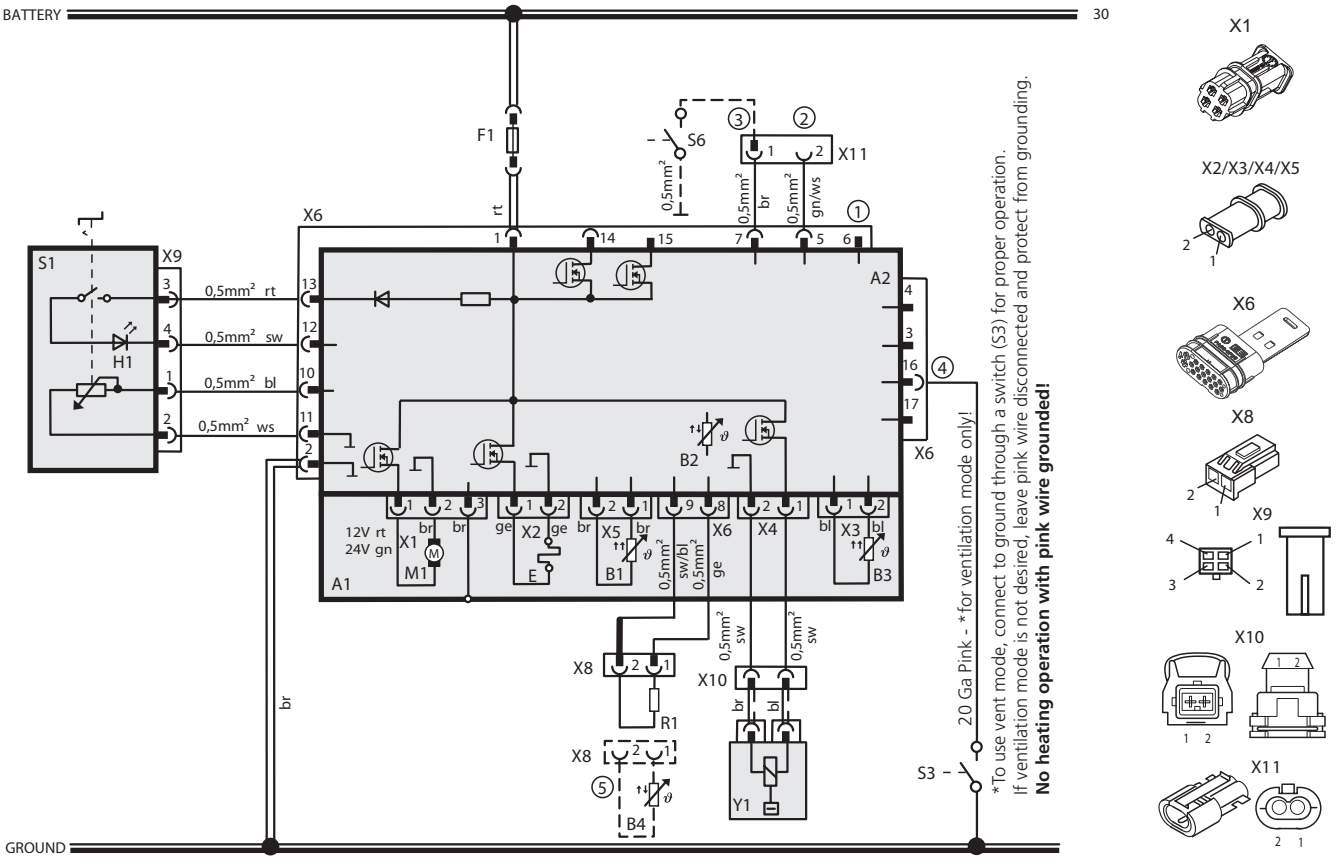
Fig. 11 shows the plug assignment on the control unit.

Fig. 14 shows the schematic connection of the combination timer.



X1 = Combustion and hot air blower connection
X2 = Ceramic glow pin connection
X3 = Overheating sensor connection
X4 = Metering pump connection
X5 = Flame sensor connection (gasoline heaters only)
X6 = Wiring harness connection

Figure 11: Plug Assignment



① Diagnostic K cable
② W bus
③ CO_2 setting
④ Input pin (pin 16/plug X6), cable color on wiring harness: pink):
"Ventilation" (fan speed depends on the position of the control element)
⑤ If you use an external temperature sensor (B4), the resistor (R1) is replaced by the temperature sensor (B4).
⑥ **NOTE** - Typical Connection for Trucks
If this connection is made to battery positive (terminal 30), permanent heating is possible with the ignition switched off. In this case no connection must be made to terminal 15/75.
⑦ **NOTE** - Typical Connection for Buses
With positive from terminal (15/75) to connection 10:
Permanent operation for immediate heat as long as the ignition is switched on.
Without positive at connection 10:
Heating time is variably programmable (10 min to 120 min), default setting 120 min.

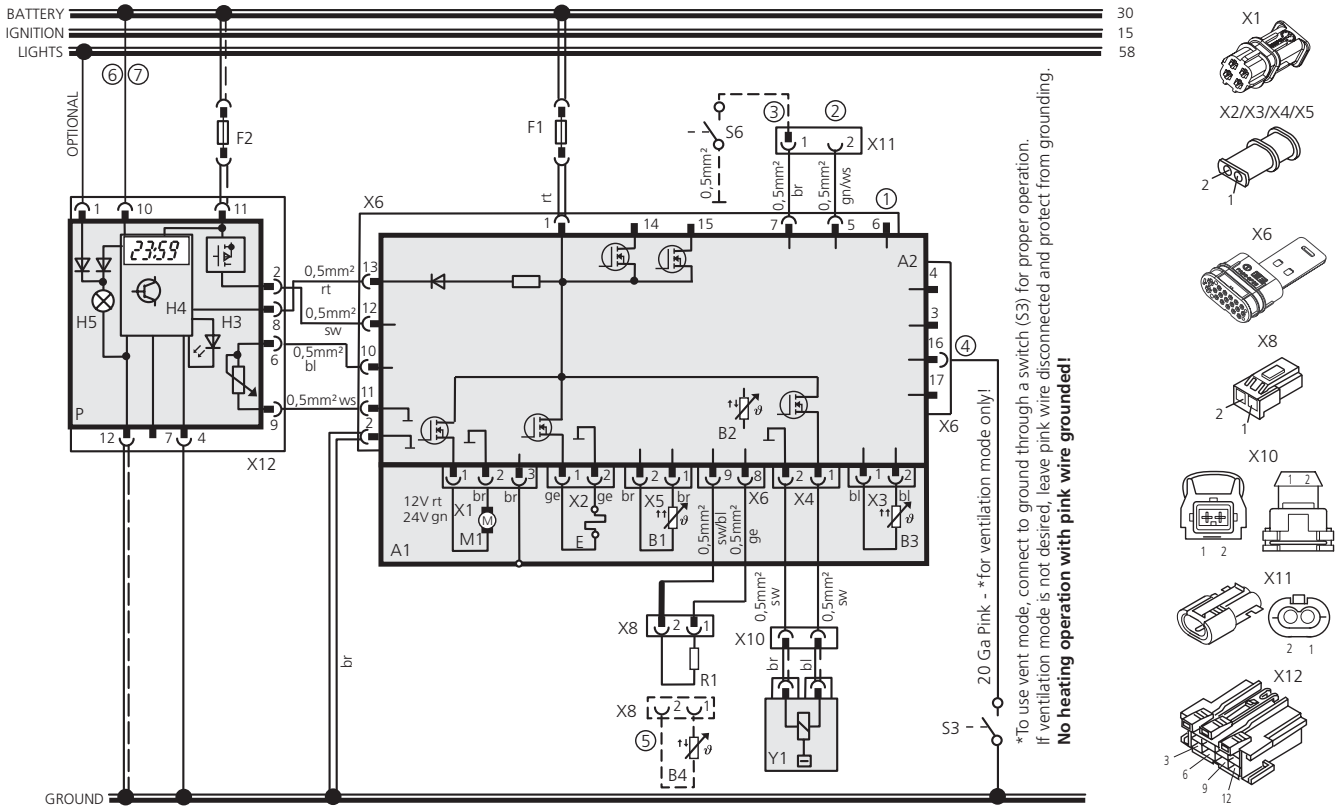
Cable Cross-sections		
	< 7.5 m	7.5 – 15 m
———	0.75 mm²	1.0 mm²
- - -	0.75 mm²	1.0 mm²
═══	1.0 mm²	1.5 mm²
▬▬▬	1.5 mm²	2.5 mm²
═══	2.5 mm²	4.0 mm²
▬▬▬	4.0 mm²	6.0 mm²
------	Standard cable	

Cable Colors	
bl	Blue
br	Brown
ge	Yellow
gn	Green
gr	Grey
or	Orange
rt	Red
sw	Black
vi	Violet
ws	White

Item	Designation	Comment
A1	Heater	Air Top 2000 ST
A2	Control unit	
B1	Flame sensor	Gasoline heaters only
B2	Temperature sensor	Internal
B3	Overheating sensor	Overheating guard
B4	Temperature sensor	External
E	Ceramic glow pin	
F1	Fuse 15A (max. 20A)	Flat fuse SAE J 1284
F2	Fuse max. 15 A	Flat fuse SAE J 1284
H1	LED, green (in item S1)	Indicator
H3	LED, red	Immediate heat button light Ready indicator, switch-on indicator
H4	Heating symbol in the display (in item P)	Indicator
H5	Light (in item P)	Display and button lights
M1	Motor	Combustion and hot air fan
P	Combination timer (1531)	Timer and temperature control

Item	Designation	Comment
R1	Resistor 620 Ω	With internal temperature sensor only
S1	Control element	Switch and temperature control
S4	Switch (optional)	Ventilation
S6	Switch	CO_2 setting
X1	Plug connector, 4-pin	to item A2
X2	Plug connector, 2-pin	to item A2
X3	Plug connector, 2-pin	to item A2
X4	Plug connector, 2-pin	to item A2
X5	Plug connector, 2-pin	to item A2
X6	Plug connector, 18-pin	to item A2
X8	Plug connector, 2-pin	
X9	Plug connector, 4-pin	to item S1
X10	Plug connector, 2-pin	to item Y1
X11	Plug connector, 2-pin	
X12	Plug connector, 12-pin	to item P
Y1	Fuel metering pump	

Figure 12: System Circuit Diagram 12V/24V with Control Element (Rheostat Switch)



① Diagnostic K cable
② W bus
③ CO_2 setting
④ Input pin (pin 16/plug X6), cable color on wiring harness: pink):
"Ventilation" (fan speed depends on the position of the control element)
⑤ If you use an external temperature sensor (B4), the resistor (R1) is replaced by the temperature sensor (B4).
⑥ **NOTE** - Typical Connection for Trucks
If this connection is made to battery positive (terminal 30), permanent heating is possible with the ignition switched off. In this case no connection must be made to terminal 15/75.
⑦ **NOTE** - Typical Connection for Buses
With positive from terminal (15/75) to connection 10:
Permanent operation for immediate heat as long as the ignition is switched on.
Without positive at connection 10:
Heating time is variably programmable (10 min to 120 min), default setting 120 min.

Cable Cross-sections		
	< 7.5 m	7.5 – 15 m
———	0.75 mm²	1.0 mm²
– – –	0.75 mm²	1.0 mm²
– – –	1.0 mm²	1.5 mm²
———	1.5 mm²	2.5 mm²
———	2.5 mm²	4.0 mm²
———	4.0 mm²	6.0 mm²
------	Standard cable	

Cable Colors	
bl	Blue
br	Brown
ge	Yellow
gn	Green
gr	Grey
or	Orange
rt	Red
sw	Black
vi	Violet
ws	White

Item	Designation	Comment
A1	Heater	Air Top 2000 ST
A2	Control unit	
B1	Flame sensor	Gasoline heaters only
B2	Temperature sensor	Internal
B3	Overheating sensor	Overheating guard
B4	Temperature sensor	External
E	Ceramic glow pin	
F1	Fuse 15A (max. 20A)	Flat fuse SAE J 1284
F2	Fuse max. 15 A	Flat fuse SAE J 1284
H1	LED, green (in item S1)	Indicator
H3	LED, red	Immediate heat button light Ready indicator, switch-on indicator
H4	Heating symbol in the display (in item P)	Indicator
H5	Light (in item P)	Display and button lights
M1	Motor	Combustion and hot air fan
P	Combination timer (1531)	Timer and temperature control

Item	Designation	Comment
R1	Resistor 620 Ω	With internal temperature sensor only
S1	Control element	Switch and temperature control
S4	Switch (optional)	Ventilation
S6	Switch	CO_2 setting
X1	Plug connector, 4-pin	to item A2
X2	Plug connector, 2-pin	to item A2
X3	Plug connector, 2-pin	to item A2
X4	Plug connector, 2-pin	to item A2
X5	Plug connector, 2-pin	to item A2
X6	Plug connector, 18-pin	to item A2
X8	Plug connector, 2-pin	
X9	Plug connector, 4-pin	to item S1
X10	Plug connector, 2-pin	to item Y1
X11	Plug connector, 2-pin	
X12	Plug connector, 12-pin	to item P
Y1	Fuel metering pump	

Figure 13: System Circuit Diagram 12V/24V with Combination Timer Model 1531

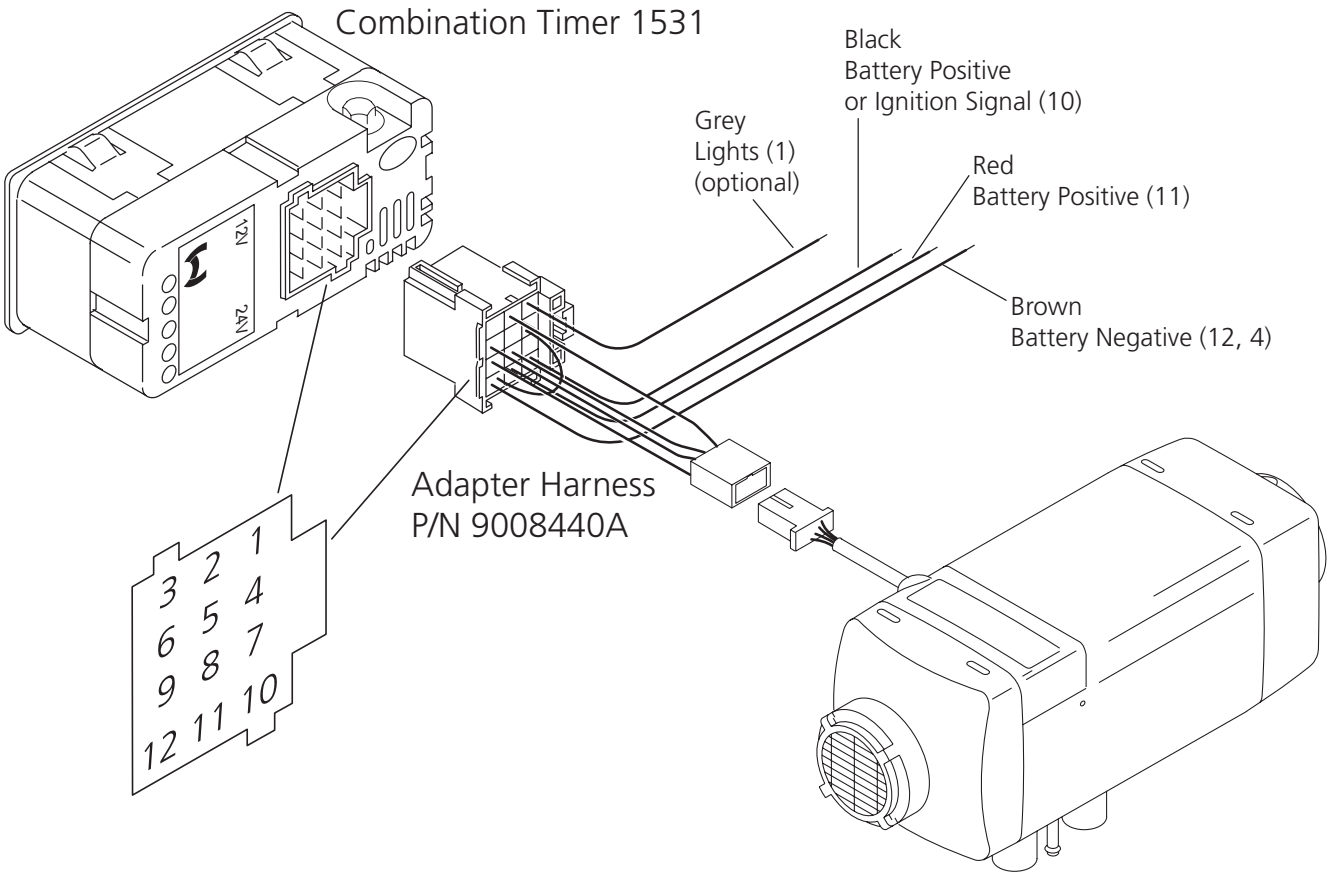


Figure 14: Schematic Connection of the Combination Timer Model 1531

8. SERVICING WORK

8.1 General

This section describes the servicing work that can be carried out on the heater when it is installed.

8.2 Work on the Heater

Disconnect the main power cable from the vehicle's battery before carrying out any work on the heater. The main battery power must not be disconnected whilst the heater is operating or slowing down as a result of the risk of the heater overheating and the overheating guard thus being tripped. If you wish to carry out extensive repair work on the heater, it may be a good idea to remove it completely.

Refer to the relevant installation instructions and the installation proposal for the heater for the specific vehicle for repairs that necessitate the installation position being changed.

8.3 Work on the Vehicle

CAUTION: A temperature of 85 °C (185 °F) must not be exceeded in the vicinity of the heater in any circumstances (for example when completing painting work on the vehicle).

8.4 Heater Trial

WARNING: The heater must not be operated in enclosed areas such as garages and workshops without an emissions extraction system, even if the heater is equipped with a timer.

CAUTION: The heater must not be operated without the cover for the control unit as this will cause it to overheat.

8.5 Servicing Work

NOTE: *The heater should be operated for approximately 20 minutes every 4 weeks to prevent mechanical parts seizing.*

The heater requires no servicing. However, it should be checked at regular intervals, at the latest at start of the heating period (the time after which the heater will be used due to adverse weather conditions) by Webasto-trained personnel.

The following servicing work is to be carried out to maintain the functional reliability of the heater:

- Check the hot air inlet and outlet for dirt and foreign bodies. (Dirty or blocked hot air lines may cause overheating.)
- Clean the exterior of the heater (avoid the ingress of water).
- Check the electrical connections for contact corrosion and to ensure that they are secure.
- Check the exhaust and combustion air lines for signs of damage and to ensure that they are clear.
- Replace the fuel filter if there is one.
- Check the fuel line and filter for leaks.

8.6 Visual Inspections and Installation Instructions

8.6.1 Hot Air System

CAUTION: The integration of the heater into the vehicle's own air system is not permitted as a result of the high pressure in the vehicle's system.

Inside the control unit there is a temperature sensor, which operates the heater in the appropriate heat output range in conjunction with the control element depending on the intake temperature and the position of the control element's dial. The heat output is set so that after the selected interior temperature has been reached quickly, it is then kept at this selected value. Alternatively, the heaters can be operated with an external temperature sensor (see 9.1.2).

NOTE: *Only materials that can permanently withstand temperatures of at least 130 °C may be used for the hot air line.*

Maximum pressure drop between the inlet and outlet side of the hot air line 1.5 hPa (corresponds to 1.5 mbar / 15 mm WC).

If this value is exceeded, the heat output may be reduced as a result of the hot air outlet temperature control.

The internal diameter of the main section of the hot air line should be 60 mm.
When using narrower lines, the permissible pressure drop is exceeded more quickly.

The hot air hose must be secured at its connection points.

The heater can be used on the air inlet and outlet side if it is used in an air circulation system with grates. Do not short circuit the flow of hot air.

CAUTION: In vehicles used to transport people, the air outlet opening is to be installed in such a way that it is at least 20 cm away from all body parts.

The heater checks the internal temperature rise automatically each time it is switched on. If this is above the specified limits, the start is cancelled and error messages F10 is displayed. To ensure that the heater functions stably, the flow resistance of the connected hot air system must be reduced.

If a filter is used for the hot air, it must have the following properties:

- The air flow must not carry any inflammable and/or harmful fibers or particles into the heater or the interior of the vehicle.
- The filter material must be able to withstand temperatures of at least 60 °C.
- The filter must be resistant to all the substances that may be drawn in with the hot air (for example moisture, salt, fuel vapors, etc.).
- The resistance of the filter must be taken into consideration when designing the hot air system.

8.6.2 Fuel Supply

The fuel is taken from the vehicle fuel tank or from a separate fuel tank. The values for the maximum pressure at the fuel extraction point are shown in Fig. 15.

Permissible fuel inflow height H (m)	At max. pressure (bar) in fuel line
0.00 m (0.00 in.)	0.20 bar (2.9 PSI)
1.00 m (39.4 in.)	0.11 bar (1.6 PSI)
2.00 m (78.7 in.)	0.03 bar (0.44 PSI)
Maximum fuel intake height S (m)	At max. negative pressure (bar) in fuel tank
0.00 m (0.00 in.)	-0.10 bar (-1.45 PSI)
0.50 m (19.7 in.)	-0.06 bar (-0.87 PSI)
1.00 m (39.4 in.)	-0.02 bar (-0.29 PSI)

8.6.2.1 Fuel Extractor (Standpipe)

Vehicles with Diesel Engines

The fuel must be taken from the vehicle fuel tank or from a separate tank (Fig. 16, 17 or 18). This separate fuel pickup precludes any effect of pressure.

Vehicles with injection Engines

When installing the heater in a vehicle with fuel injection systems, it is important to establish whether the fuel pump is located inside or outside the tank.

If the fuel pump is located inside the tank, fuel can only be extracted from the return line using a Webasto fuel tee fitting in which case it must be ensured that the return line continues almost to the bottom of the tank. If this is not the case, a Webasto fuel standpipe (see Fig. 16, 17 or 18) may be used.

If the fuel pump is installed outside the tank, the fuel connection may also be made between the tank and the fuel pump, again using only the Webasto fuel tee fitting.

Vehicles with Carburetor Engines

The fuel may only be extracted on cars using a special Webasto fuel tee fitting as close to the tank as possible. The connection may be made in either the supply or return line, in which case the return line must lead almost to the base of the tank. If this is not the case, the return line may be extended.

The fuel tee must be fitted in such a way that any air or gas bubbles are automatically discharged towards the tank.

The fuel tee should not be located near the engine, as gas bubbles may form in the lines on account of heat radiated from the engine. This may cause problems during combustion.

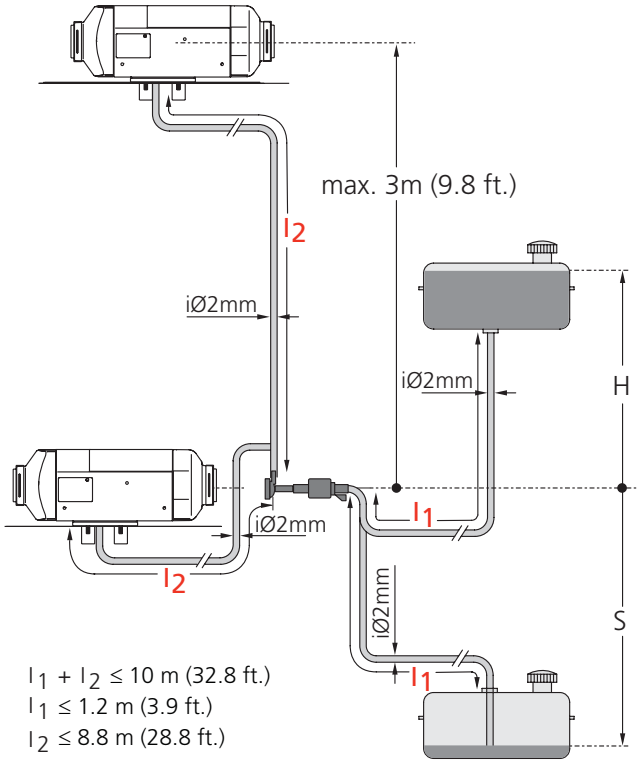


Figure 15: Fuel supply

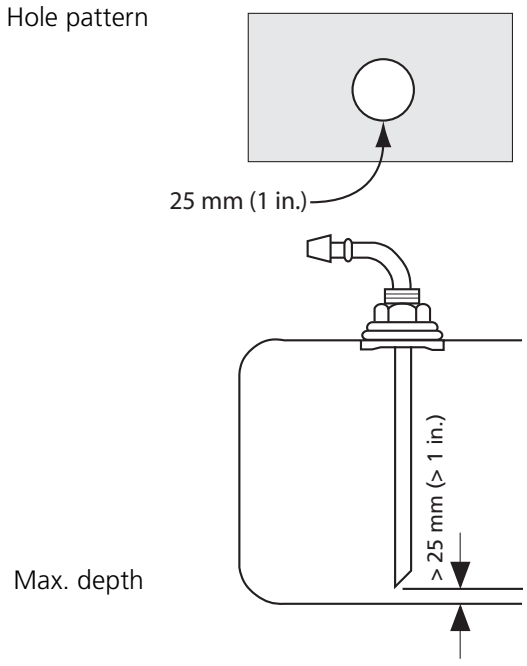


Figure 16: Webasto fuel standpipe

NOTE: *Only use this style of standpipe with metal fuel tanks.*

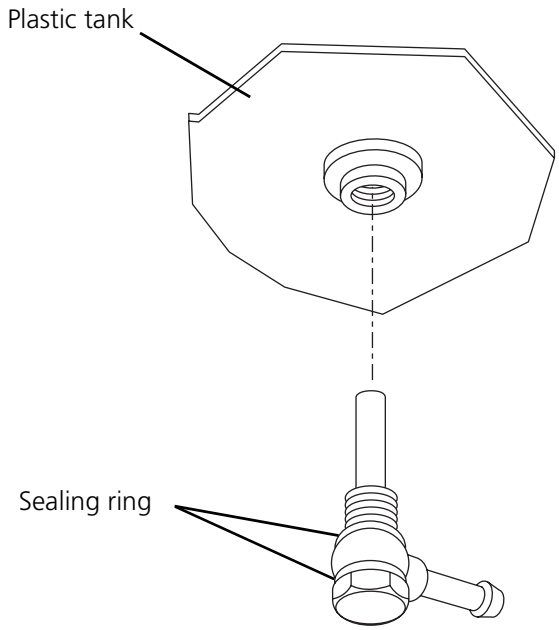


Figure 17: Fuel extractor from a plastic or metal tank (extraction through tank drain screw)

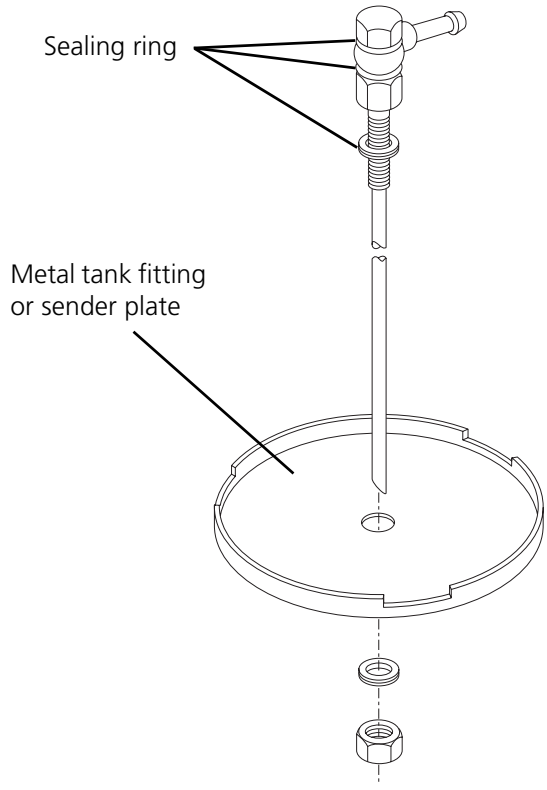


Figure 18: Fuel standpipe for a plastic or metal tank (extraction through metal tank fitting)

NOTE: *The tank or fitting must be made of metal.*

8.6.2.2 Fuel Lines

Only steel, copper and plastic lines of plasticized, light and temperature-stabilized PA11 or PA12 (for example Mecanyl RWTL) according to DIN 73378 may be used for the fuel lines. Since the lines cannot normally be routed with a constant rising gradient, the internal diameter must not be allowed to exceed a certain size. Air or gas bubbles will accumulate in lines with an internal diameter of more than 4 mm and these will cause malfunctions if the lines sag or are routed downwards. The diameters specified in Fig. 15 will ensure that bubbles do not form.

The lines should not be routed downwards from the metering pump to the heater.

Unsupported fuel lines must be secured to prevent them sagging. They must be installed in such a way that they cannot be damaged by flying road debris and high temperatures (exhaust line).

The fuel lines must be secure at the connections using hose clips to prevent their slipping.

Connecting two pipes with a hose

The correct procedure for connecting fuel lines with hosing is shown in Fig. 19.

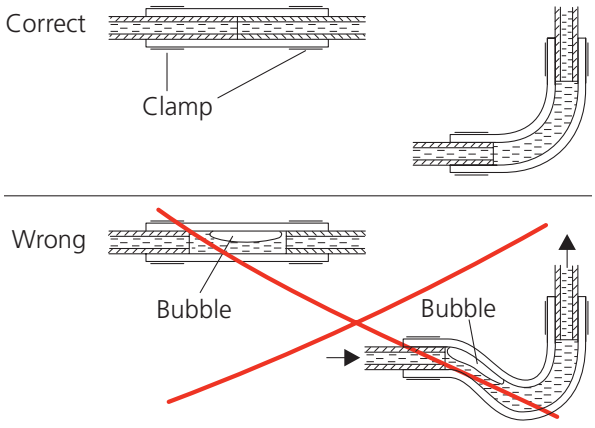


Figure 19: Pipe/Hose connections

8.6.3 Fuel Metering Pump

The metering pump is a combined delivery, metering and shut-off system and is subject to certain installation criteria (Fig. 15 and 20).

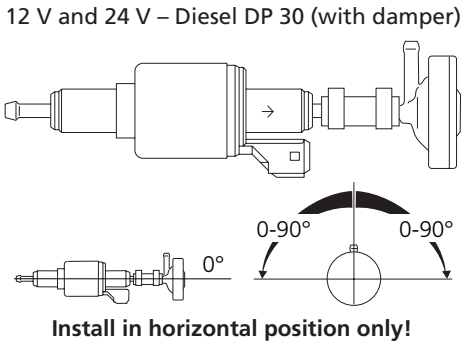


Figure 20: Metering pump, installation position and attachment

8.6.3.1 Installation Location

It is advisable to install the metering pump in a cool place. The maximum ambient temperature must not exceed +20 °C (+68 °F) at any time during operation.

The metering pump and fuel lines must not be installed within range of the radiated heat from hot vehicle parts. A heat shield must be used if necessary.

8.6.3.2 Installation and Attachment

The metering pump must be secured with a vibration-damping mounting. Its installation position is limited as shown in Fig. 20 in order to ensure effective automatic bleeding. As a result of the risk of corrosion, only genuine Webasto parts may be used for the plug connections between the metering pump and the metering pump wiring harness.

8.6.4 Fuel Filter

Only a Webasto filter, P/N 50487171A, is allowed to be used if the fuel is expected to be contaminated. Install vertically if possible, however at most horizontally (check flow direction).

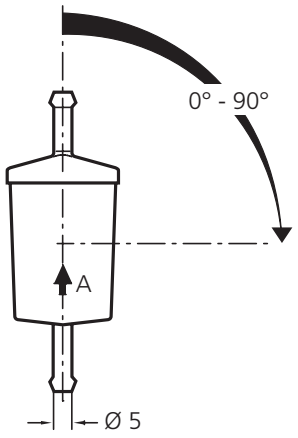


Figure 21: Fuel filter

8.6.5 Combustion Air Supply

Under no circumstances may the combustion air be taken from areas occupied by people. The combustion air intake opening must not point in the direction of travel. It must be located so that it cannot become clogged with dirt.

NOTE: *The combustion air must be extracted using a combustion air line from a position that is as cool as possible and protected from splashing water for petrol heaters.*

If the heater is in a sealed installation box, the combustion air must be drawn in from the outside and the emissions fed to the outside. Pipe passage holes must be made in such a way as to ensure that the ingress of exhaust fumes into the interior of the vehicle should not occur.

If dirty combustion air is expected, a combustion air filter may be fitted (only Air Top 2000 ST D). If the intake hose length is < 0.6 m (2 ft), an intake silencer must be used.

8.6.6 Exhaust Line

Rigid pipes of unalloyed or alloyed steel with a minimum wall thickness of 1.0 mm (3/64 in) or flexible piping of alloyed steel only must be used as the exhaust line. The exhaust pipe must be secured to the heater and exhaust muffler with a pipe clip, P/N 20965A.

The exhaust muffler (Fig. 22) should ideally be installed near the heater. The flow direction is arbitrary.

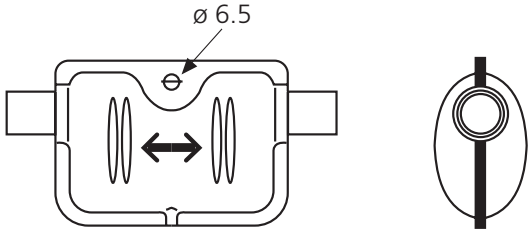


Figure 22: Exhaust muffler

The heater may also be operated without a muffler.

8.6.7 Combustion Air Inlet and Exhaust Lines

To prevent damaging the metering pump cable, exhaust line must not be used to extend the combustion air supply line.

Length of the combustion air inlet and exhaust lines:

With muffler:	max. 2.0 m (6.5 ft)
Without muffler:	max. 5.0 m (16.4 ft)

Both lines are to be installed falling away from the heater. If this is not possible, a condensate drain hole with a diameter of 4 mm must be made at its lowest point or a connection element with a condensate drain used.

Internal diameter of the lines:

Combustion air line:	22 mm (7/8 in)
Exhaust line:	22 mm (7/8 in)

NOTE: *If the exhaust line is over 2 m in length, insulated lines must be used (to prevent falling below the dew-point).*

Minimum bending radius: 50 mm (2 in)

An attachment is required no further than 150 mm (6 in) from the end of the exhaust pipe to ensure that the angle of 90° ± 10° is achieved.

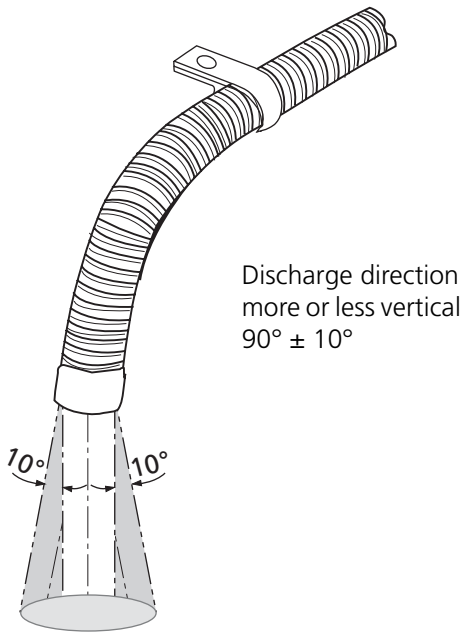


Figure 23: Exhaust pipe mouth, installation position

WARNING: If the exhaust pipe mouth is positioned other than as shown in Fig. 23, it will pose a fire risk.

Total bends:

Combustion air line:	max. 270°
Exhaust line:	max. 270°

8.6.8 Electrical Connections

8.6.8.1 Heater Connection, Control Element

The electrical connection is to be made as shown in the appropriate circuit diagram (see section 7).

To connect the wiring harness, remove the cover (see 9.2.1.1) on the heater and connect the wiring harness plug to the control unit.

Before using the heater for the first time fit the cover to prevent the illegal escape of hot air (heater overheating).

The wiring harness can be fed out of the left or right side of the heater.

8.6.8.2 Supply Voltage Connection

Ideally from the vehicle's central electrical system.

An additional blade terminal fuse holder is to be fitted to protect the heater and harness (supplied with the heater). The fuse holder should be installed as close as is practical to the power source e.g. in the vehicle battery enclosure.

The fuse holder is constructed of weather resistant components.

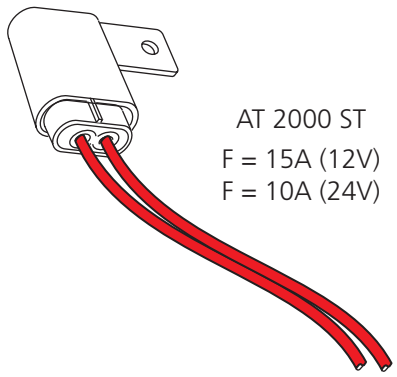


Figure 24: Weather Resistant Fuse holder

8.6.8.3 Control Element (Rheostat) Connection

The wiring harness is prepared for connection to the control element (rheostat switch).

Simply pull on connector housing to disconnect the connector (Fig. 26).

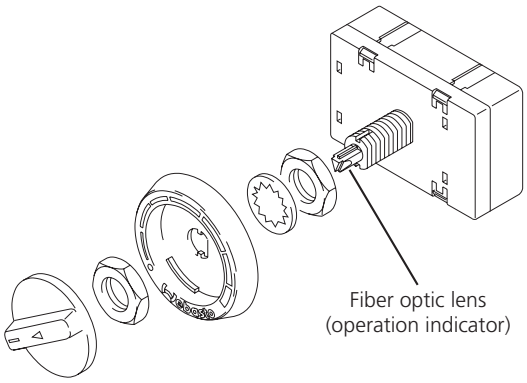


Figure 25: Control element (rheostat switch)

NOTE: *The fiber optic lens must be in contact with the rotary knob.*

NOTE: *The connector housing can be locked (self-locking action) by simply pulling on the wiring harness.*

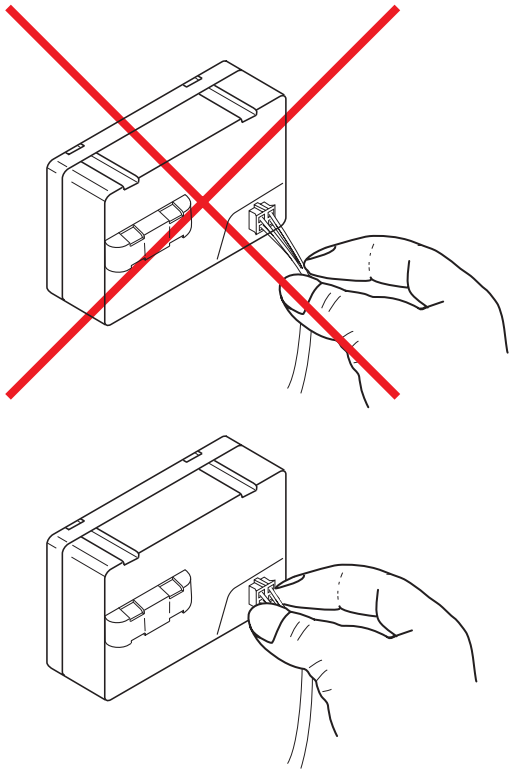


Figure 26: Disconnecting the plug

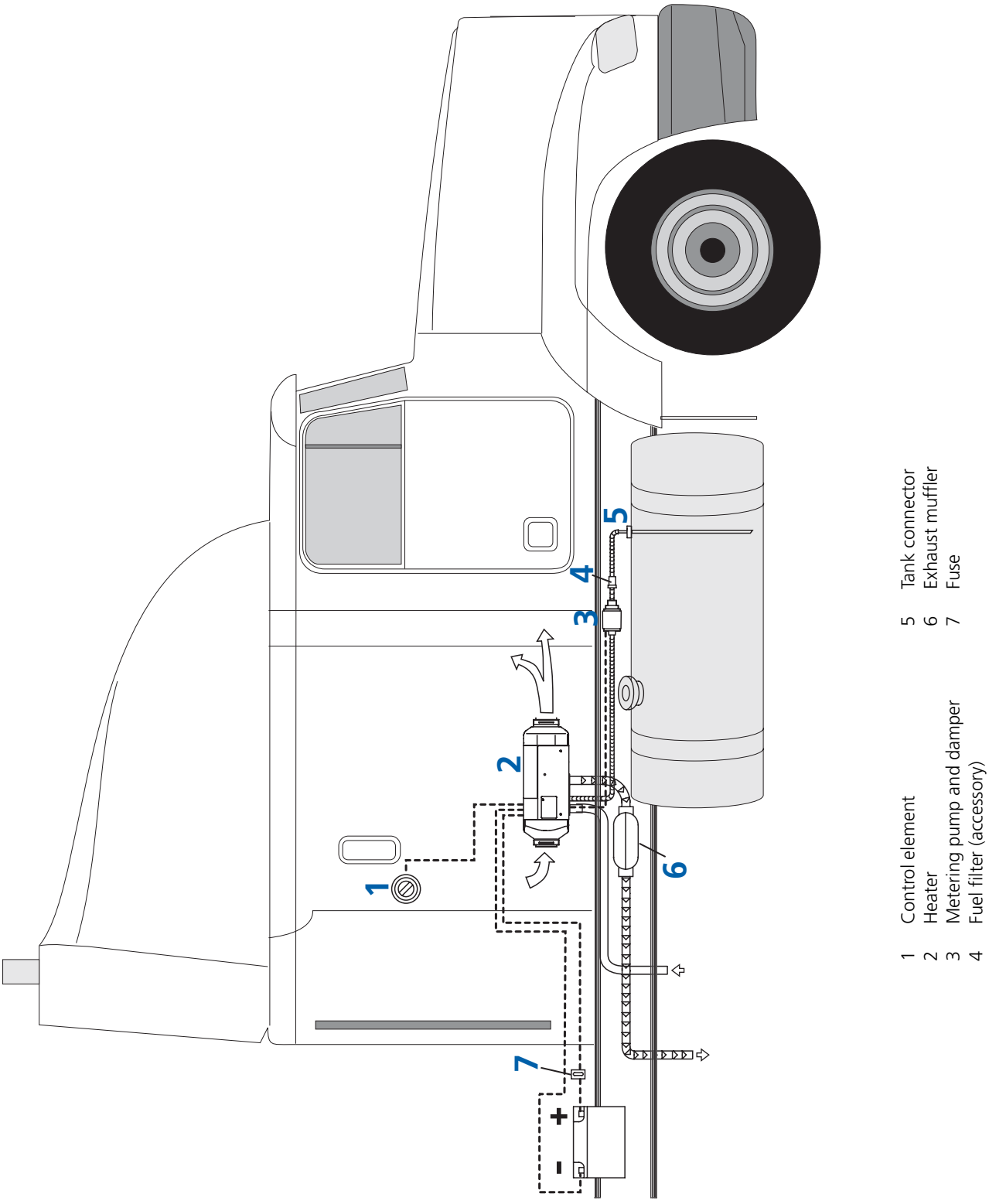


Figure 27: Example installation for heater in an air circulation system

8.7 Removal and Installation

CAUTION: When the heater is installed it must not be dismantled.

8.7.1 Heater, Removal and Installation

8.7.1.1 Removal

1. Disconnect the battery.
2. Pull the cover off the top shell as described in 9.2.1.1
3. Disconnect the wiring harness plug from the control unit.
4. Disconnect the cable to the metering pump at the disconnection point.
5. If necessary disconnect the hot air hose or hoses.
6. Disconnect the connection for the combustion air inlet on the heater.
7. Disconnect the connections for the combustion air inlet and exhaust outlet on the heater.
8. Remove four nuts and locking washers from the heater.
9. Remove the heater and discard the seal on the exhaust outlet.

8.7.1.2 Installation

1. Place the heater with a **new** seal on the exhaust outlet in the installation position and secure it with 4 nuts and locking washers (use only genuine Webasto nuts).
2. Tighten the nuts to 6 + 1 Nm (63 + 9 lb-in).
3. Secure the connection for the combustion air inlet on the heater.
4. Secure the connections for the combustion air inlet and exhaust outlet on the heater.
5. Connect the metering pump cable to the metering pump wiring harness.
6. Connect the wiring harness plug to socket X6 of the control unit.
7. Fit the cover and secure it.
8. If necessary fit the hot air hose or hoses and secure them.
9. Connect the battery.
10. Bleed the fuel supply system (see 8.8).

8.8 Start-up

After you have installed the heater, bleed the fuel supply system carefully.

NOTE: *As a result of the low fuel consumption the heater must be switched on several times to fill the fuel line.*

Conduct a trial of the heater to check all the connections for leaks and to ensure that they are secure. If the heater suffers a fault during operation, the fault must be located and remedied.

9. REPAIR

9.1 General

This section describes the repair work that may be carried out on the Air Top 2000 ST heater after it has been removed from the vehicle. Any further dismantling will invalidate the warranty. Only use the spare parts from the appropriate spare parts kits for assembling the heater.

9.1.1 Work on Stripped-down Components

CAUTION: All sealing elements between the stripped-down components and the seal on the exhaust outlet must always be discarded and replaced.

9.1.1.1 Cleaning

- Clean all stripped-down components with benzene and then dry them with compressed air.
- Remove all seal residue on the components carefully using a suitable tool.

9.1.1.2 Visual Inspection

- Check all components for damage (cracks, deformation, wear, etc.) and fit new ones if necessary.
- Inspect the plugs and cables for corrosion, loose contacts, crimping faults, etc. and repair them if necessary.
- Check plug strips for signs of corrosion and contacts to ensure they are secure. Repair them if necessary.

9.1.2 Carrying out Modifications

The constant development of our heaters is aimed at optimizing them so as to prevent failures and malfunctions.

Generally it is possible to modify heaters that are already in use. We can supply the appropriate modification kits for this purpose.

The following describes modifications that can be carried out without any great effort during standard repair work:

- Installation of an external temperature sensor for better temperature control (see 9.1.2.1).

9.1.2.1 Installation of an External Temperature Sensor

General

The heater can control the required temperature perfectly if its temperature sensor is exposed to the air of the main area of the vehicle. In certain circumstances, this is not always possible using the temperature sensor integrated in the control unit due to the installation circumstances (addition of fresh air). In this case proper temperature control can be ensured using an external temperature sensor fitted in the appropriate area.

Method

1. Select a suitable position for an external temperature sensor.

IMPORTANT

- **The temperature sensor should not be in the direct line of hot air and not close to heat sources (for example the vehicle's own heating system).**
- **The sensor is to be installed at medium height in the vehicle cabin on surfaces that are as vertical as possible.**
- **The installation site should not be exposed to direct sunlight.**
- **Do not install the temperature sensor behind curtains or the like.**

2. Install the external temperature sensor and route the cable to the control element.
3. Remove the terminating resistor at plug X8 of the wiring harness (see Fig. 28).
4. Connect the external temperature sensor at plug X8 of the wiring harness.
5. Conduct a trial and check the control properties.

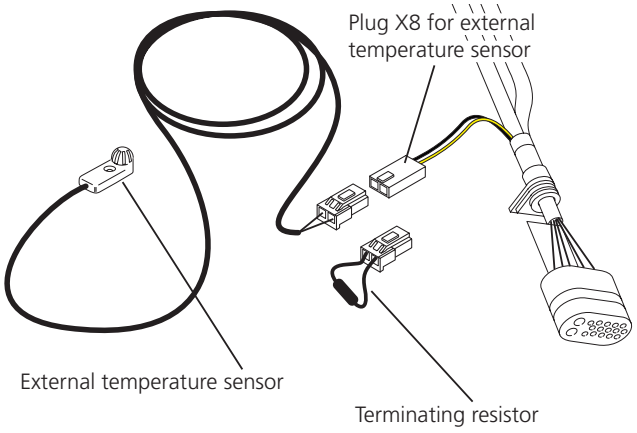


Figure 28: External Temperature Sensor

9.2 Dismantling and Assembling

9.2.1 Remove the Casing Parts

9.2.1.1 Cover for Electrical Connection

The cover (1, Fig. 29) can be levered off using a blunt blade in the areas Ⓧ.

9.2.1.2 Grates for Hot Air Inlet and Outlet

The grates (5) can be released from the mounting by twisting and pulling off forwards.

9.2.1.3 Cover for Hot Air Inlet and Outlet

Both covers (3 and 6, Fig. 29) can be released from their mountings and removed by pressing the four detents at the top and bottom using a suitable tool.

9.2.1.4 Top Shell

NOTE: *The covers for the hot air inlet and outlet must have been removed.*

The shell (2, Fig. 29) can be raised by pulling up.

9.2.1.5 Bottom Shell

By gently pulling the bottom shell (4, Fig. 29) on both sides in the areas Ⓨ, you can release the fixing and the shell can be taken off the motor casing.

9.2.2 Fit the Casing Parts

9.2.2.1 Bottom Shell

IMPORTANT! To ensure that the heater and the overheating sensor work perfectly, please note the following when fitting the casing:

- Four insulators are used as spacers between the heat exchanger and the casing parts.
- Slide the four insulators (8, Fig. 29) onto the four corner ribs of the heat exchanger and position exactly next to the rib extension.
- Check that all four insulators (8, Fig. 29) are securely positioned.

CAUTION: When you fit the bottom shell (4, Fig. 29), spread it slightly so that the spacers on the overheating sensor (8, Fig. 30) are not damaged.

1. Expand the bottom shell (4, Fig. 29) slightly at the side and fit it to the heater from underneath until the securing pins on the heater engage in the holes in the shell.
2. Fit a new seal on the exhaust outlet.

9.2.2.2 Top Shell

1. Place the top shell (2, Fig. 29) on the heater and secure it in the grooves in the bottom shell.

9.2.2.3 Cover for Hot Air Inlet and Outlet

NOTE: *The covers for the hot air inlet and outlet are different. Fit the cover with the smaller opening at the front on the hot air blower.*

1. Push on the covers (3 and 6, Fig. 29) until the four securing holes engage properly in the detents on the bottom and top covers.

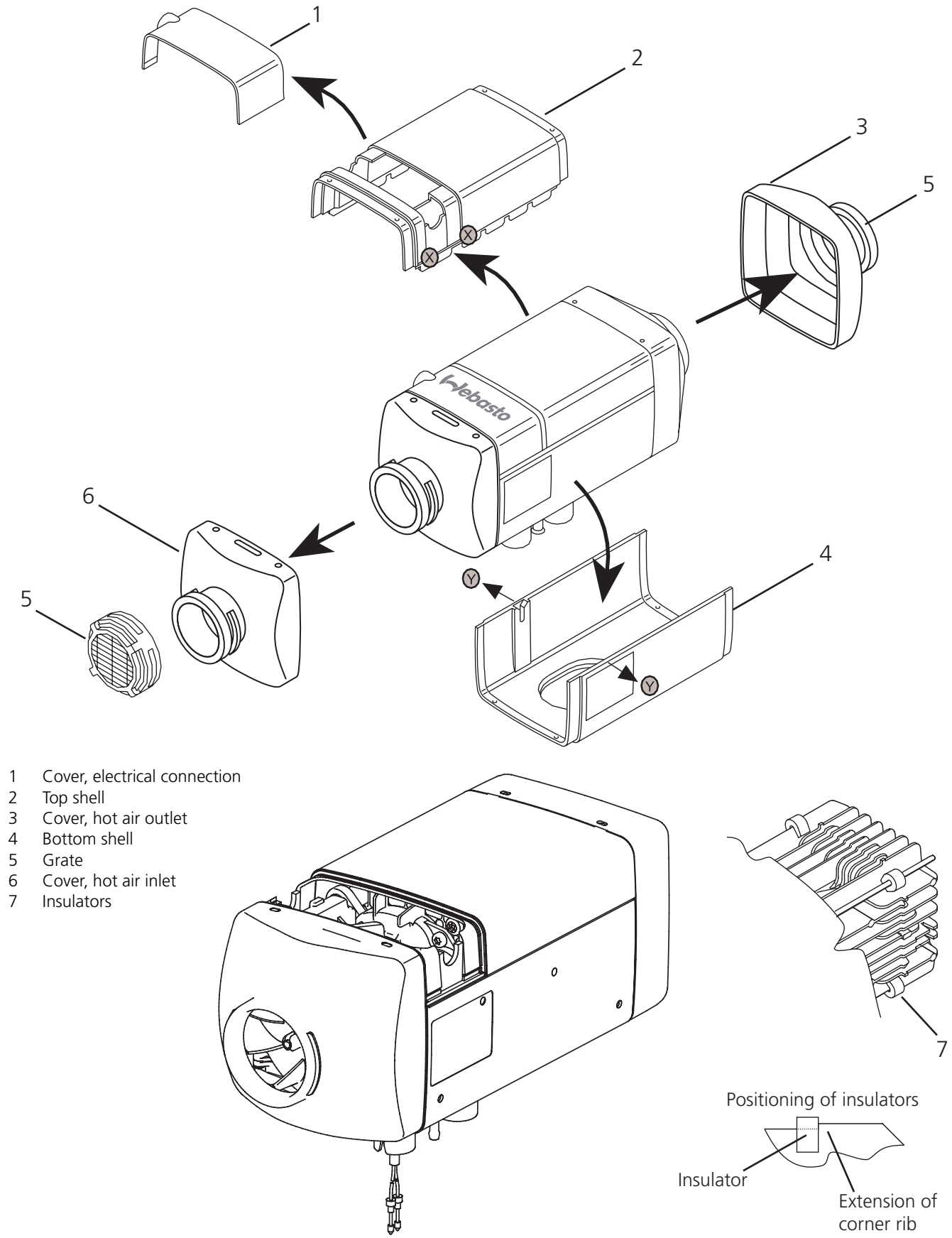
9.2.2.4 Grates for Hot Air Inlet and Outlet

Fit the grates (5, Fig. 29) on the covers for the hot air inlet and outlet and twist them to secure them.

9.2.2.5 Cover for Electrical Connection

NOTE: *The wiring harness is to be taken out of the left or right of the heater to suit the installation situation.*

1. Fit the cover (1, Fig. 29) until it audibly engages in the top cover.



1 Cover, electrical connection
2 Top shell
3 Cover, hot air outlet
4 Bottom shell
5 Grate
6 Cover, hot air inlet
7 Insulators

Figure 29: Remove / Fit the Casing Parts

9.2.3 Changing the Control Unit

9.2.3.1 Removal

1. Remove the heater (see 8.7.1.1).
2. Remove the casing parts (see 9.2.1).
3. Open the catches on the hot air blower.
4. Pull the hot air blower (1, Fig. 30) off the motor shaft by hand.
5. Disconnect the plug connectors on the control unit (3).
6. Remove screws (2) and the control unit (3).
7. Complete the work on stripped-down components (see 9.1.1).

NOTE: *Do not carry out any repair work to the control unit.*

9.2.3.2 Installation

1. Place the control unit (3, Fig. 30) in the installation position and attach with screws (2).
2. Tighten the screws to 0.7 ± 0.07 Nm (6 ± .6 lb-in).
3. Slide the hot air blower (1) onto the motor shaft until the detente on both sides is heard to engage in the shaft groove at the stop.
4. Connect the plug connectors at the sockets of the control unit (3) as shown in Fig.11.
5. Position the casing parts (see 9.2.2).
6. Install the heater (see 8.7.1.2).
7. Check the CO_2 setting and adjust it if necessary (see 6.2).
8. Check that the hot air blower moves easily with your hand. Check for any noise when you switch it on later. The sensor magnets on the hot air blower must be clear of ferrous chips, etc.

9.2.4 Changing the Overheating Sensor

9.2.4.1 Removal

9.2.4.1 Removal

1. Remove the heater (see 8.7.1.1).
2. Remove the casing parts (see 9.2.1).
3. Remove the insulators (9, Fig. 30).
4. Disconnect the plug connector X5 on the control unit (3).

CAUTION: Do not pull the cables.

5. Lever the overheating sensor (8) out of the ribs of the heat exchanger (7) using a suitable tool (see detail A, Fig. 30).
6. Remove the overheating sensor (8).

9.2.4.2 Installation

1. Measure the resistance of the overheating sensor (8, Fig. 30) (see 6.3.3).
2. Position the overheating sensor (8, Fig. 30) on the heat exchanger (7) and press it into place by hand.

IMPORTANT! There must not be an electrical connection between the sensor cables and the sheet metal holder.

3. Ensure that the overheating sensor is correctly positioned in the heat exchanger (7).
4. Connect the plug connector X5 at the control unit (3). Check that the cables are routed in parallel between the ribs on the heat exchanger.
5. Push the insulators (9) on to the heat exchanger.
6. Position the casing parts (see 9.2.2).
7. Install the heater (see 8.7.1.2).

9.2.5 Changing the Combustion Air Fan

9.2.5.1 Removal

1. Remove the heater (see 8.7.1.1).
2. Remove the casing parts (see 9.2.1).
3. Remove the control unit (see 9.2.3.1).

NOTE: *A total of 9 screw heads are visible on the combustion air fan (5, Fig.* 30*). Of these the 5 outer screws are used to attach the combustion air fan to the heat exchanger (7). Only these screws should be removed.*

4. Remove the screws (4).
5. Remove the combustion air fan (5) from the heat exchanger (7), remove the seal (6) and dispose of it separately.
6. Complete the work on stripped-down components (see 9.1.1).

9.2.5.2 Installation

1. Ensure that the sealing surfaces on the combustion fan (5, Fig. 30) and on the heat exchanger (8) are not damaged.
2. Fit a new seal (7) on the flange of the combustion air fan (5).

3. Bring the combustion air fan (5) into the assembly position and secure with screws (4), attaching the electrical bonding of the wiring harness to the motor at the same time.
4. Tighten the screws (4) to 6 ± 0.6 Nm (53 ± .5 lb-in).
5. Fit the control unit (see 9.2.3.2).
6. Position the casing parts (see 9.2.2).
7. Install the heater (see 8.7.1.2).
8. Check the CO_2 setting and adjust it if necessary. (see 6.2).

9.2.6 CHANGING THE FLAME SENSOR (GASOLINE HEATERS ONLY)

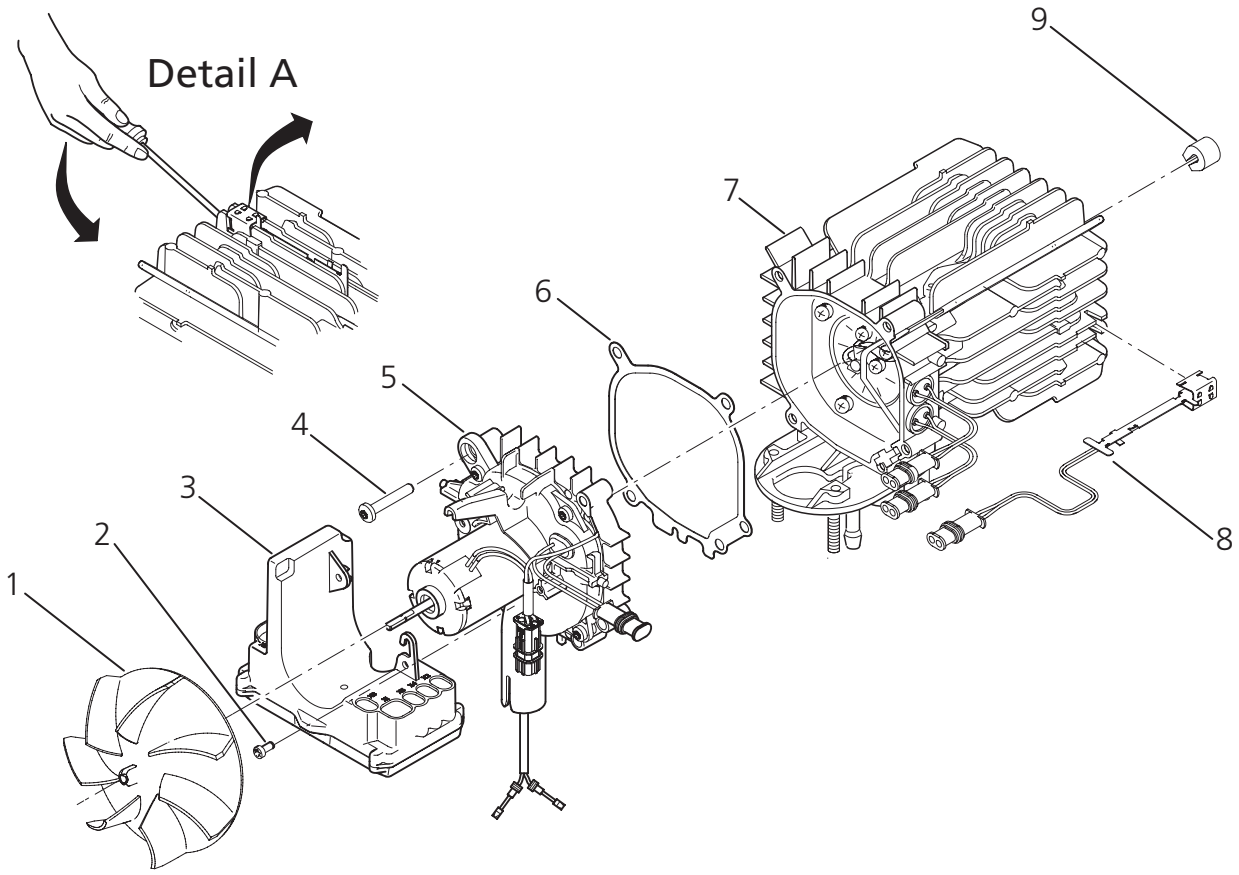
9.2.6.1 REMOVAL

1. Remove the heater (see 8.7.1.1).
2. Remove the casing parts (see 9.2.1).
3. Remove the control unit (see 9.2.3.1).
4. Remove the combustion air fan (see 9.2.5.1).
5. Remove two screws (2, Fig. 31) and take off the air baffle (3).
6. Press the cable grommet (11) on the flame sensor connecting cable inwards out of the heat exchanger (9).
7. Carefully bend up the securing strap (4) and pull out the flame sensor (1) from the burner insert.
8. Remove flame sensor
9. Complete the work on stripped-down components (see 9.1.1).

9.2.6.2 INSTALLATION

CAUTION: Install the flame sensor cable under the fuel line.

1. Slide the flame sensor (1, Fig. 31) through under the fuel line, insert the plug through the hole in the heat exchanger (9) and press the cable grommet (11) into the heat exchanger (9) from inside.
2. Insert the cable with the protective sheath through the securing strap (4) and insert the flame monitor (1) into the burner insert (5).
3. Press the securing strap (4) back together.
4. Secure the air baffle (3) with screws (2).
5. Tighten the screws (2) to 6 ± 0.6 Nm (53 ± .5 lb-in).
6. Pull the cable of the flame sensor tight.
7. Install the combustion air fan (see 9.2.5.2).
8. Fit the control unit (see 9.2.3.2).
9. Position the casing parts (see 9.2.2).
10. Install the heater (see 8.7.1.2).



1 Hot air fan rotor
2 Torx screw (3)
3 Electronic control unit
4 Torx screw (5)
5 Combustion air fan (drive unit)
6 Seal
7 Heat exchanger
8 Overheating sensor
9 Insulator (4)

Figure 30: Changing the Control Unit, Combustion Air Fan and Overheating Sensor

9.2.7 Changing the Ceramic Glow Pin

9.2.7.1 Removal

1. Remove the heater (see 8.7.1.1).
2. Remove the casing parts (see 9.2.1).
3. Remove the control unit (see 9.2.3.1).
4. Remove the combustion air fan (see 9.2.5.1).
5. Press the cable grommet (10, Fig. 31) inwards out of the heat exchanger (9).
6. Remove four screws (2) and take off the air baffle (3).

NOTE: *Check that the burner insert (5) is detached from the combustion pipe (13).*

7. Carefully remove the burner insert (5) by tilting.

CAUTION: The glow plug should be removed with extreme care and must not be twisted under any circumstances (risk of breakage). After lengthy operation of the burner the glow plug may be fixed in place by fuel deposits. In this case apply penetrating oil and allow to work until the glow plug can be removed.

8. Release the screw (7), pull out the glow plug (6) from the burner insert and remove.
9. Remove the combustion pipe (13) and seal (12) from the heat exchanger (9) and dispose of the seal separately.
10. Complete the work on stripped-down components (see 9.1.1).

9.2.7.2 Installation

1. Fit a new seal (12, Fig. 31) into the heat exchanger (9) and bring the combustion pipe (13) into the assembly position.
2. Check that the starting air hole in the burner insert (5) is free. If necessary, clean with a wire, approximately 4 mm Ø (5/32 in Ø) (see Fig. 32).

CAUTION: When installing the glow plug, make sure that the contacts point to the heat exchanger. Otherwise there is a risk of a short-circuit.

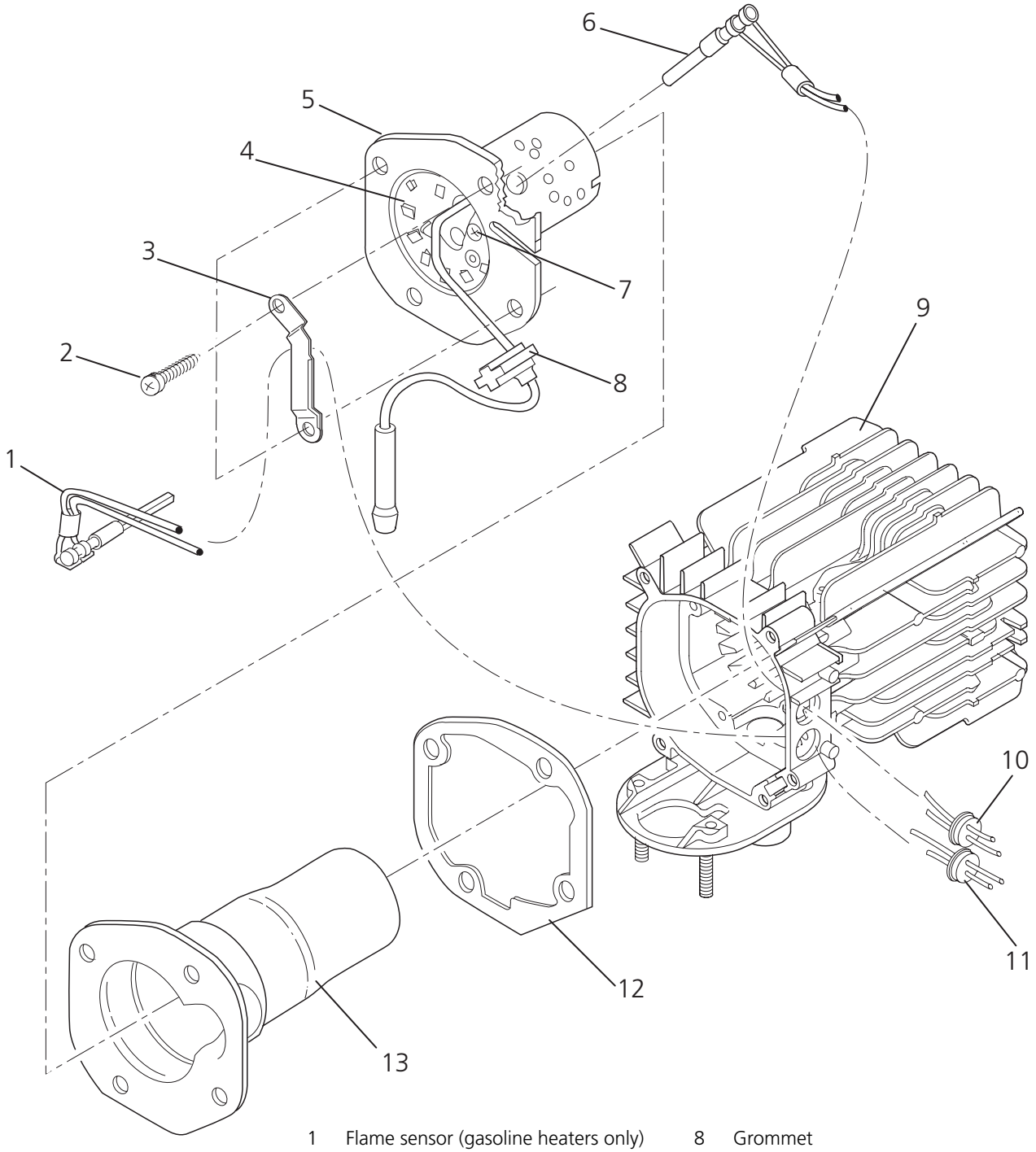
3. Introduce the glow plug (6) in the burner insert (5) and position the protective sheath in the slit of the burner insert.

CAUTION: In the following procedure make sure that the glow plug is placed in the burner insert up to the stop.

4. Secure the glow plug (6) with the screw (7). Tighten the screw (7) to 0.5 Nm (4.4 lb-in).
5. Introduce the burner insert (5) in the heat exchanger (9). Make sure that the cable of the flame sensor (1) (only present with petrol heater) is positioned under the fuel line.
6. Guide the plug of the glow plug and the flame sensor through the holes and press the cable grommets (10) into the heat exchanger.

CAUTION: In the following procedure make sure that the grommet (8) seals off tight with the heat exchanger (9).

7. Secure the burner insert (5) and the air baffle (3) with screws (2). Tighten the screws (2) to 6 ± 0.6 Nm (53 ± .5 lb-in).
8. Install the combustion air fan (see 9.2.5.2).
9. Fit the control unit (see 9.2.3.2).
10. Position the casing parts (see 9.2.2).
11. Install the heater (see 8.7.1.2).



1	Flame sensor (gasoline heaters only)	8	Grommet
2	Torx screw (4)	9	Heat exchanger
3	Securing strap	10	Cable grommet
4	Air baffle	11	Cable grommet (gasoline heaters only)
5	Burner insert	12	Seal
6	Ceramic glow pin	13	Combustion pipe
7	Screw		

Figure 31: Changing the glow plug, flame sensor, combustion insert and the heat exchanger

9.2.8 Changing the Burner Insert, Combustion Pipe and the Heat Exchanger

9.2.8.1 Removal

1. Remove the heater (see 8.7.1.1).
2. Remove the casing parts (see 9.2.1).
3. Remove the control unit (see 9.2.3.1).
4. Remove the overheating sensor (see 9.2.4.1).
5. Remove the combustion air fan (see 9.2.5.1).
6. Remove the flame sensor (only petrol heater) (see 9.2.6.1).
7. Remove the glow plug (see 9.2.7.1).

CAUTION: In the following procedure make sure that the fuel connection is not bent.

8. Remove the burner insert (5, Fig. 31).
9. Remove the combustion pipe (13) and seal (12) from the heat exchanger (9) and dispose of the seal (12) separately.
10. Complete the work on stripped-down components (see 9.1.1).

9.2.8.2 Installation

1. Fit a new seal (12, Fig. 31) into the heat exchanger (9) and bring the combustion pipe (13) into the assembly position.

NOTE: *The burner insert (5) is only fixed in place when installing the flame sensor and glow plug.*

2. Fit the glow plug (see 9.2.7.2).
3. Fit the flame sensor (gasoline heaters only) (see 9.2.6.2).

CAUTION: In the following procedure make sure that the fuel connection is not bent.

4. Introduce the burner insert (5) in the heat exchanger (9). Make sure that the cable of the flame sensor is positioned under the fuel line.
5. Secure the burner insert (5) and the air baffle (3) with screws (2).
6. Tighten the screws (2) to 6 ± 0.6 Nm (53 ± .5 lb-in).
7. Install the combustion air fan (see 9.2.5.2).
8. Fit the control unit (see 9.2.3.2).
9. Fit the overheating sensor (see 9.2.4.2).
10. Fit the insulators (11).
11. Position the casing parts (see 9.2.2).
12. Install the heater (see 8.7.1.2).

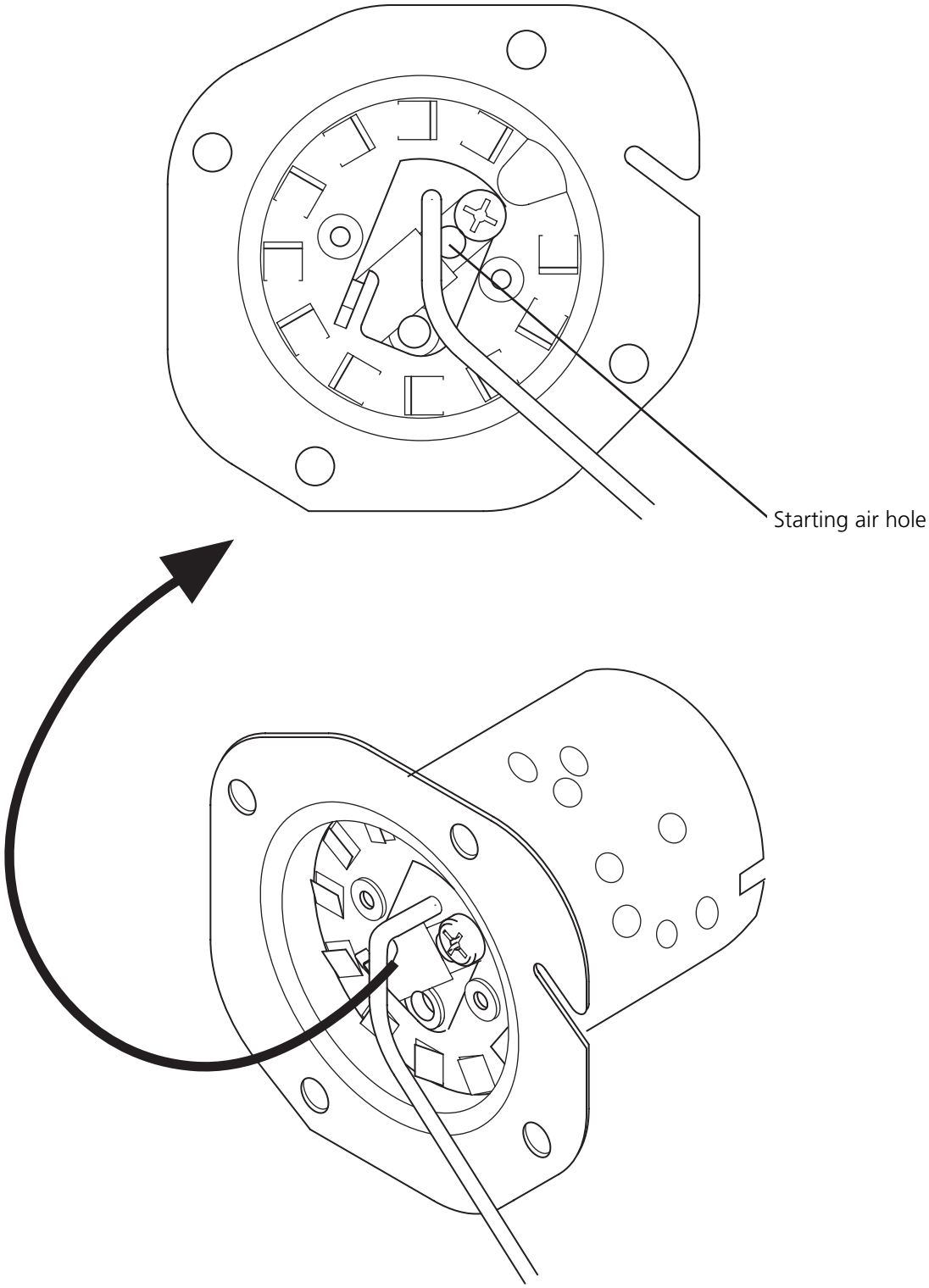


Figure 32: Starting air hole in burner insert

10. PRODUCT INFORMATION

No new or updated information available at this time.

This page for your notes.

WARRANTY COVERAGE AND LIMITATIONS

Webasto Product North America, Inc. (herein after referred to Webasto) warrants their heaters and heater kits against defects in material and workmanship for two (2) years effective at the time of installationor vehicle registration date for Original Equipment installations (OE). This warranty period may not exceed three (3) years from the original date of sale by Webasto. This warranty period may be superseded by a contractual agreement.*

**Warranty coverage for Marine and Off-road applications containing DBW series heaters and the CSL Cargo Heaters are limited to a maximum of 3,000 hours of usage. All other models are limited to 2,000 maximum hours.*

Replacement parts are covered for six (6) months or the remainder of the original warranty period, which ever is longer. Replacement heaters are considered a "Replacement Part."

The intent of the Webasto warranty is to protect the end-user heater from such defects and provide free repair and replacement of defective parts in the manner provided herein. During the warranty period the exclusive remedy will be for Webasto, at their discretion, to repair or replace those parts which are demonstrated to be defective in material or workmanship.

While warranty is provided to the "end-user", it is to be administered and serviced through an authorized Webasto dealer in accordance with the Webasto warranty policy or contractual agreement between Webasto and a second party.

Limitations: Webasto specifically excludes and limits from warranty the following:
- Normal wear of service parts: **(fuel nozzles, filters and overheat fuses are not covered).**
- Removal and replacement of heater (with the exception of the Thermo Top C).
- Damage to product in transit. All claims must be filed with carrier.
- Improper installation, which is not in accordance with valid, supplied installation instructions or approved OEM applications.
- Deterioration due to normal wear, corrosion, abuse, damage, accident, improper storage or operation.
- Modification of product by alteration, use of non-genuine parts or repair by unauthorized personnel.
- Economic loss for expenses related to travel, vehicle disability, personal injury or other incidental or consequential damages arising from any breach of this expressed warranty.

Owner's Responsibilities:
1) Service heater at the start of each season by an authorized Webasto dealer (Service parts including; fuel nozzles, filters and overheat fuses are not covered under warranty).
2) A Warranty Registration Card is included with the sale of each heater. It is the owner's responsibility to complete this card and return it to Webasto for registration. A proof of purchase is required for all heaters that are not registered.

This warranty gives you specific legal rights and you may also have other rights which vary by State or Province

THE WARRANTY DESCRIBED IN THIS POLICY SHALL BE IN LIEU OF ANY OTHER WARRANTY, EXPRESSED OR IMPLIED, INCLUDING BUT NOT LIMITED TO, ANY IMPLIED WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE.

Webasto

Feel the drive

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